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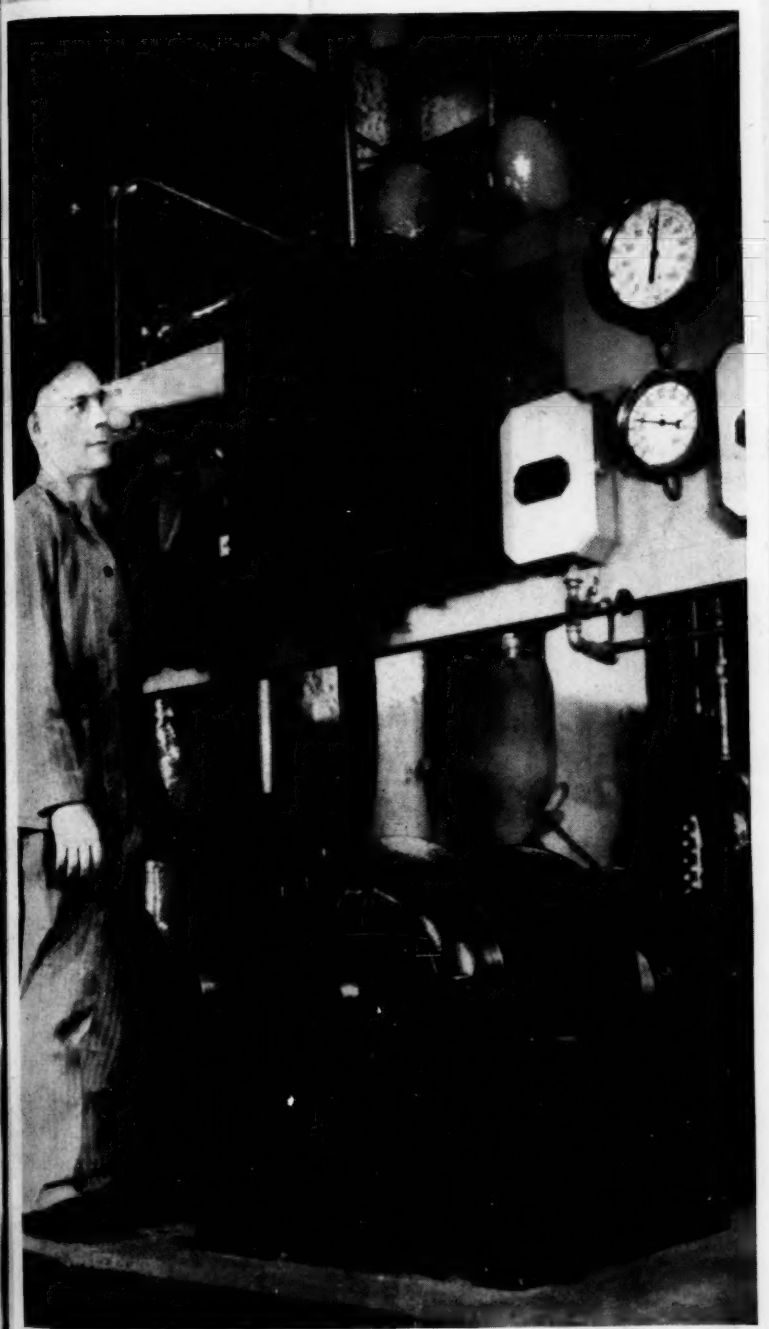

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COVER: CONTROL PANEL FOR TWO HOUSE-SERVICE PUMPS AT CARSON PIERIE SCOTT STORE, CHICAGO. EACH DELIVERS 1300 GPM AGAINST HEAD OF 145 FT.

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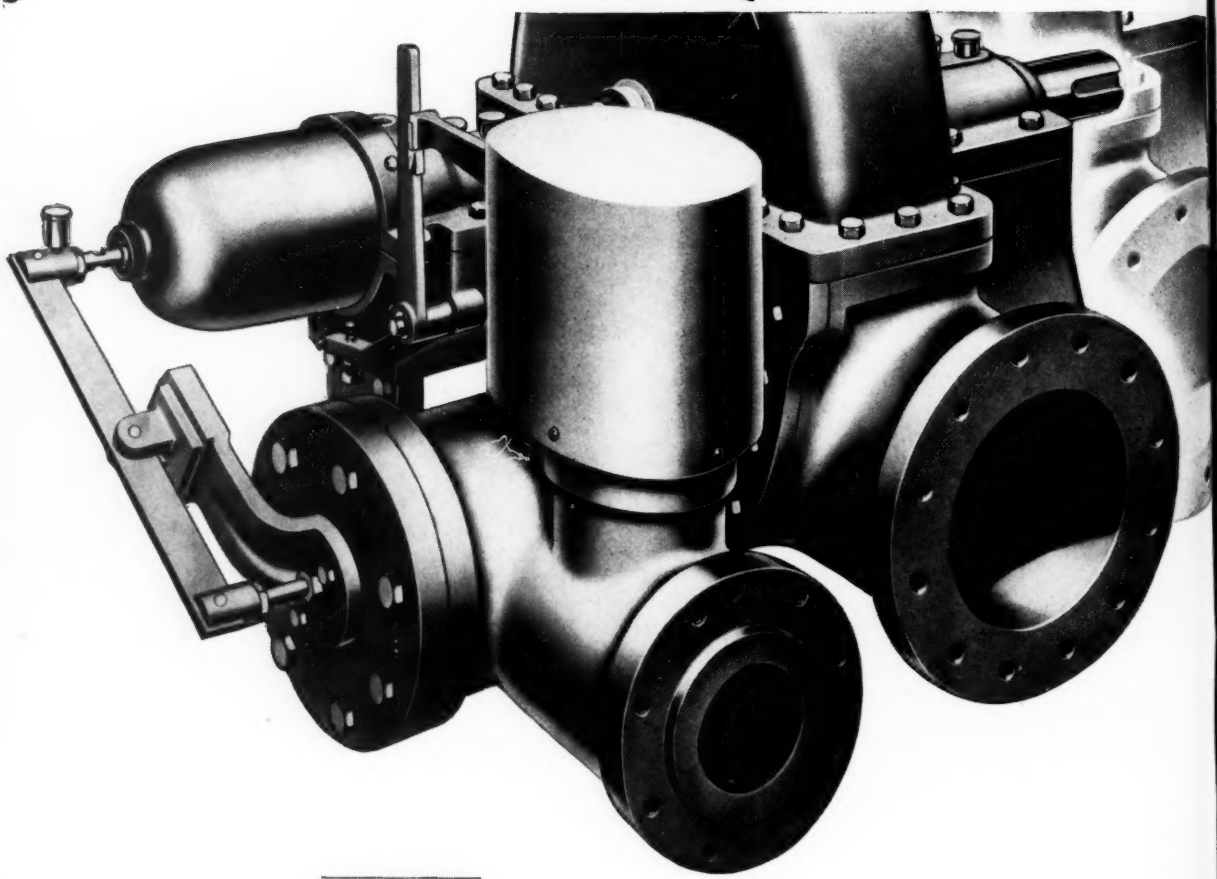
JUNE, 1947

Announcing **another**



Elliott

Power Plant ENGINEERING

June, 1947

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EDITORIAL STAFF

RALPH E. TURNER
Editor

ANDREW W. KRAMER
Managing Editor

CHESTER R. EARLE
Associate Editor

THOMAS E. HANSON
News Editor

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ABC

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How to plan HIGH PRESSURE BOILER BLOWDOWN CONNECTIONS

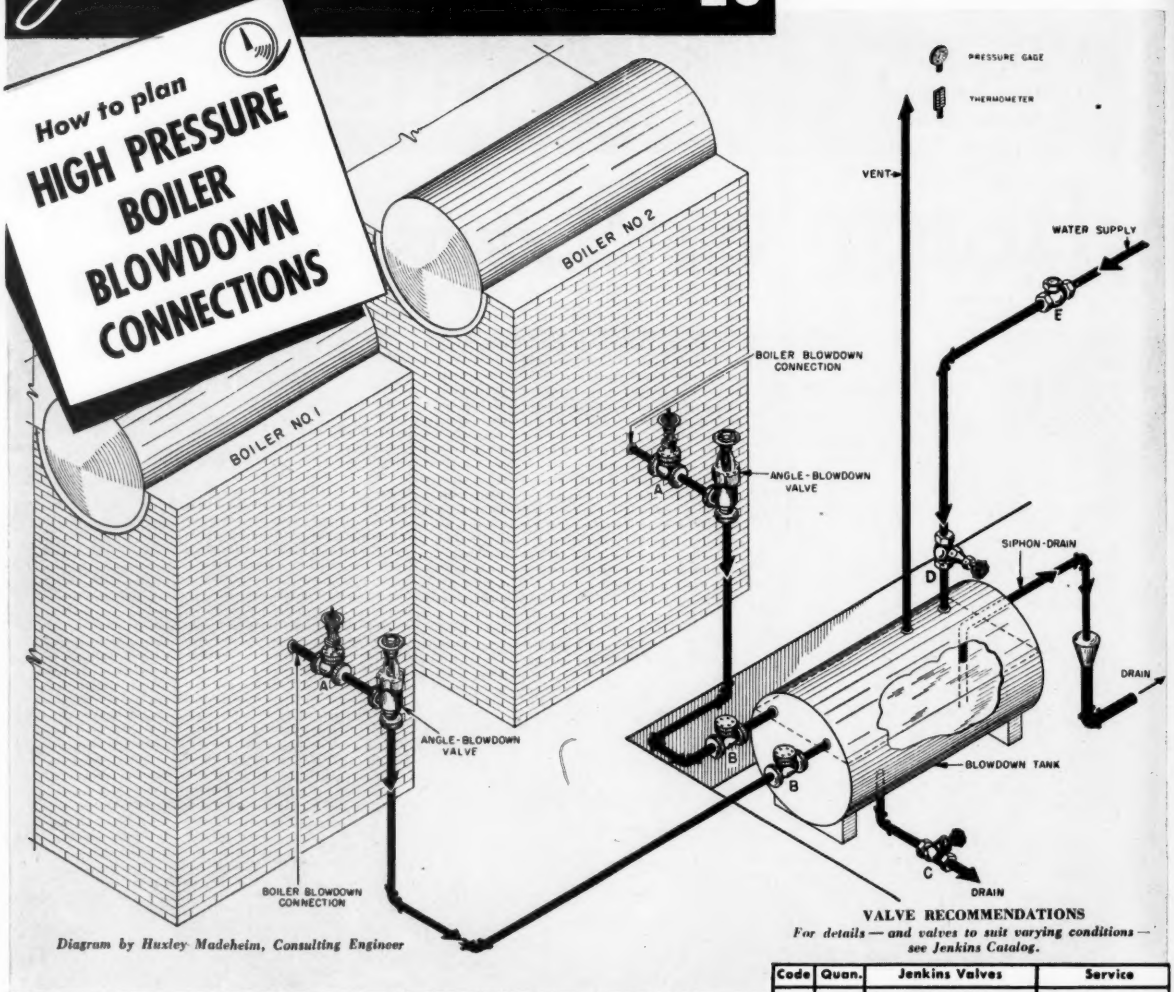

Diagram by Huxley Madeheim, Consulting Engineer

VALVE RECOMMENDATIONS

For details — and valves to suit varying conditions — see Jenkins Catalog.

Code	Quan.	Jenkins Valves	Service
A	2	Fig. 1012 Cast Steel Gate	Blow down Shut-off
B	2	Fig. 1028 Cast Steel Check	Prevent Back flow
C	1	Fig. 124 Bronze "Y"	Tank Drain
D	1	Fig. 106-A Bronze Globe	Water Regulation
E	1	Fig. 117-A Bronze Lift Check	Prevent Back flow

A typical blowdown hookup for a plant with two or more boilers operating at a high pressure—in this case 450 psi—is shown in this diagram. The system meets the ASME code and most other codes, all of which are rigidly enforced.

ASME code requirements call primarily for two valves in tandem on each boiler blowdown line, an independent connection of each blowdown line to the blowdown tank, and use of a blowdown tank. Jenkins Gate Valves insure tight shut off of blowdown when not in use and provide unrestricted flow during blowdown. Independent lines prevent one boiler from filling or plugging the line of the other. A vented tank allows for release of pressure before discharging to the sewer and prevents injury to the operator. Tank hookup meets city codes in respect to safety and anti-contamination.

Copies of Layout No. 23, enlarged, with additional information, will be sent on request . . . also future Piping Layouts. Just mail coupon.

Other types and pressure ranges of Jenkins Valves can be used for this layout, according to factors involved. Consultation with accredited piping engineers and contractors is recommended on major installations.

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DEPARTMENT OF REPRODUCTION

ENGINEERS' PREVIEW

IT LOOKS as though the dollar is to be superseded, not in actuality but in terminology, by a new unit more suitable to modern conditions. In some of the projects that are now being planned for the coming age of atomic energy, rockets, etc., the costs of the laboratories and factories in which the future will be manufactured is now being expressed in "mega-bucks." A mega buck is equivalent to $1,000,000.

★ ★ ★

MAGNETIC RECORDINGS on wire or tape are issuing a strong challenge to the discs. One machine of each type is now commercially available and is beginning to make a stir. In Chicago, Sears Roebuck & Co. sold 1000 sets of its combination wire recorder, phonograph and radio in the first three days it was offered at $169.50. Earlier in New York the Soundmirror had found easy sales at $229.50. That is a magnetic tape recorder made by Brush Development Co. not including radio or phonograph. Lear Inc. plans to market a combination wire recorder, FM and AM radio and phonograph, according to a recent report in *Business Week*. Altogether some 60 firms are expected to bring out home recorders using either wire or paper tape. Commercial uses of these recorders are being predicted on a wide scale. The ramifications of the idea in recording radio programs, listening to your own speeches, etc. are endless. One problem will be their use in connection with telephone service, now being discussed, for it is not likely that the manufacturer of a recorder for home or commercial use will want to equip it with the necessary signals for warning to telephone users. But the battle is on and we may soon be giving you details of the effective use of a wire or tape sound recorder in power house work, where already its buddy, television, has made its debut.

★ ★ ★

A NEW PROCESS for quick aging of whiskey breaks up the liquor into its components, then reassembles it. This secret Disticraft process uses principles similar to the cracking process for refining petroleum products, according to a recent announcement in *Business Week*. It is supposed to produce a mature whiskey in 72 hours.

★ ★ ★

DESPERATE and continued need for American publications to serve as tools of physical and intellectual reconstruction abroad has been made vividly apparent by appeals from scholars in many lands. The American Book Center for War Devastated Libraries has been urged to continue meeting this need at least through 1947. The Book Center is therefore making a renewed appeal for American books and periodicals —for technical and scholarly books and periodicals in all fields and particularly for publications of the past ten years. It will especially welcome complete or incomplete files of POWER PLANT ENGINEERING. Ship your contributions to the American Book Center, c/o The Library of Congress, Washington 25, D.C. freight prepaid, or write to the Center for further information.

IN THE MIDST of its weekly radio broadcast "Echoes of New York," Consolidated Edison Co. of New York recently made a quick shift of scene and picked up its "around-the-town" reporter, George Hicks, interviewing Watch Engineer Alexander Connal inside the furnace of one of high-pressure boilers installed at Sherman Creek Station. This was the unit described by R. T. Roberts, Division Engineer, Mechanical Engineering Department, Consolidated Edison Co. in POWER PLANT ENGINEERING, February 1947, page 108. Judging by the transcription of the radio interview, Engineer Connal and Mr. Hicks did a pretty good job of making the ordinary radio listener understand the tremendous size of this steam generating unit and the tremendous quantities of coal, air and water that it consumes in the initial step of the transformation of coal energy into electricity. More than 40 tons of pulverized coal and 700 tons of air every hour; 500 tons of water every hour passing through the tubes at a pressure of 1800 psi, etc. This unit as our readers will remember, is one of the 1,000,000-lb-per-hr Combustion Engineering Co. boilers, designed for 1800 psi, 955 F.

★ ★ ★

IN THE OIL FIELDS of Oklahoma and California, a dramatic race is taking shape as man drills ever deeper into earth searching for oil. Two wildcat wells, one owned by Superior Oil Co. of California, and the other by Pacific Western Oil Co., are waging a neck-and-neck contest for the world's oil well depth record. Pacific Western's well near Lost Hills, Kern County, California, was shoved down to a world's record depth of 16,668 ft on December 2. Then the drill pipe stuck 13 ft off bottom and drilling was stopped. Two months later Superior Oil Company's well, five miles north of Fort Cobb in Caddo County, Oklahoma, reached 16,668 ft, equalling Pacific Western's mark. Drilling was halted temporarily to change drill bits and then was resumed. This well now is past the 16,668-ft mark. This drilling is actual physical drilling, not radar sounding.

★ ★ ★

ANALYSIS of the causes of corrosion experienced with metals used for steam generating tubes and superheater tubes in high pressure boilers, and some recommendations as to what can be done to overcome this problem, were presented before the Louisville Congress of the Electro-Chemical Society by Paul M. Brister, Staff Engineer, and J. B. Romer, Chief Chemist, of The Babcock & Wilcox Co. of New York. For high temperature superheater tubes, the paper showed how temperature shock effects the rate of corrosion on the steam side and the gas side of the tube. "With proper selection of ferritic type chromium-molybdenum steel alloys, steam and flue gas corrosion is not troublesome for metal temperatures up to about 1200 F," the authors stated. "Stainless steels are satisfactory for temperatures somewhat above 1200 F. For structural members, such as hangars and supports, chromium-nickel steel alloys are preferred for high temperature service."

THERE IS a great need, says T. G. MacGowan in the *Industrial Bulletin*, for new products and better ones—not products which are simply new to any one company and which will serve merely to take business away from others without enlarging the market—but products that will be wholly new or will be enough better or enough cheaper to create additional buying and enlarge consumption. From purely selfish considerations, such products offer the best means of expansion.

★ ★ ★

ONE MORE PLAN for a research and development program for making gasoline and gas fuel of high heat value from bituminous coal has just been announced by Pittsburgh Consolidation Coal Co. Working in collaboration with Standard Oil Development Co. and with arrangements made for contributing to the studies of Hydrocarbon Research, Inc., also engaged in this work, a pilot plant of demonstration size will be used to perfect and commercialize processes already under development on a laboratory scale. It will be erected at Library, Pa., near the Pittsburgh company's newly organized research center. The pilot plant will consume about 50 tons of coal a day and produce 2,400,000 cu ft of gas suitable for synthesis into liquid and gas fuels. A commercial plant for making liquid fuels and the high-Btu gas, which they hope might be ready for operation by 1950 or 1951, could be located within some 25 miles of Pittsburgh, adjacent to one of the company's huge coal tracts. One single plant of the size being considered could yield a gas of high heat value in quantities equal to the output of the Big Inch and Little Inch pipe lines and create a local source of gasoline, Diesel and other fuel oils and a certain amount of alcohols. One feature of the projected program is its flexibility of production to yield 400,000,000 cu ft of gas a day in the winter months, cut this in half during the summer, when the plant would be set up to produce 14,000 barrels of high-octane gasoline per day at a time when motor consumption is highest.

★ ★ ★

REPORTING on the artificial production of snow by sowing clouds with pellets of dry ice (see *Engineers' Preview*, April, page 162) we said that if this should lead to the making of rain, the consequences might be, to say the least, fantastic. We don't know yet how fantastic—but we have just learned that rain HAS been made by this method. Colonel E. S. Ellison, Portland, Orgeon weatherman, claims that, sowing dry ice pellets in a cloud by airplane, he produced snow first and the snow then changed to rain and fell to the earth. Photographs made from another plane at a distance are offered in evidence.

★ ★ ★

NEW METHOD of radiant heating employing electrically-heated ceilings is operating successfully in an experimental house at Knoxville, Tenn. The electrified ceilings, developed by United States Rubber Co., contain a heating element of conductive rubber sandwiched between two thin layers of plastic. The entire ceiling in each room becomes warm, producing enough heat to keep every nook and corner at a comfortable and uniform temperature.

ELECTRONIC BOMBARDMENT, a new method of cleaning optical glass surfaces prior to coating, was discussed by Collin H. Alexander at the recent meeting of the Optical Society of America. The ground and polished optical glass is placed in a metal holder in a high vacuum bell, where a tungsten filament, similar to the filament in an ordinary electric light bulb, is electrically heated to a temperature at which electrons are "boiled out." Since electrons are negative particles, they are attracted by the holder which is at high plus-voltage with respect to the filament. Thus attracted, the electrons bombard the glass at a speed of several thousand miles a second, leaving the surface entirely free of water and extraneous material. After cleaning, the glass, still contained in the high vacuum chamber, is coated with aluminum by an evaporation process. The result: A mirror of extremely high precision such as required for televising purposes.

★ ★ ★

IMPROVED METAL protective coating invented by C. K. Sloan and G. D. Patterson is prepared from an alkyd resin vehicle having a very low moisture permeability. The pigmented coating composition must comprise at least 10 per cent by weight of calcium chromate based on the total pigment present. The alkyd vehicle selected should have a water-impermeability value of at least 5 at film thickness of 0.005 after six months' outdoor exposure. The resultant coating is said to have merit with respect to can stability, rapidity of drying, durability, and high efficiency in inhibitive value.

★ ★ ★

ROTATING SPEEDS of several thousand rpm are common in the power and industrial fields but mention of millions of rpm caught our attention when reported about a year ago by Ernest Hix in his famous newspaper cartoon strip entitled, "Strange As It Seems." Mr. Hix reported that the fastest speed man has ever attained with a solid object was the speed of a $\frac{1}{16}$-in. diameter steel rotor spun at 12,660,000 rpm. The experiments in which this speed was attained were carried out at the Rouss Laboratory at the University of Virginia. Since that time, by the same methods, they have caused a slightly smaller rotor to operate at a speed of 633,000 rps or approximately 38,000,000 rpm. The diameter of the rotor was 0.521 mm. It was a spherical shape of hardened steel suspended magnetically in a vacuum and spun by a rotating magnetic field. It atttained a peripheral speed of 1.04×10^5 cm per sec, which is not too fast; but it should be noted that at that speed the centrifugal acceleration was 4.28×18^8g or 428,000,000 times gravity.

★ ★ ★

DRESINOL, a new chemical, which substantially reduces the cost of secondary recovery of crude oil by water flooding, and at the same time increases the output of oil, was revealed recently by Don Martin, Hercules Powder Co. Dresinol, a selective plugging agent, is pumped down ordinary water intake wells. It plugs the most permeable layers of sand which no longer have recoverable oil so that water forced down the intake well exerts pressure on more tightly packed layers of sand and forces previously untapped oil deposits to output wells.

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILERS, INSULATION

1 **Steam Generators** — Bulletin 1000-E describes this company's fully automatic unit steam generator. Illustrative material consists of several photographs, which show the exterior of the unit and one exceptionally good cutaway wash drawing which shows the flow of water, steam and products of combustion. Detailed descriptions of the unit are presented and two charts show typical boiler performance for high-pressure units—one burning light oil and the other heavy oil. A table presents dimensional data on the unit and this table is accompanied by a dimensioned line drawing. Typical installations are pictured. Preferred Utilities Mfg. Co.

2 **Increasing Boiler Capacity** — "Increase Your Boiler Capacity—Now!" is the title of this new 4-page bulletin on sectionally-supported boiler walls. The bulletin tells about some of the jobs now under way and points out the practicability of this method of increasing boiler capacity of your present units. A full-page drawing illustrates the principle of construction of these walls and features and advantages of the walls are explained. Geo. P. Reintjes Co.

3 **Insulating Cement**—This collection of data sheets includes a 4-page folder which describes the company's insulating cement for use on the exterior of boilers, heaters, and piping. Heat loss charts and tables of physical properties of the insulation accompany drawings showing how the insulation is applied. The other sheets in the collection give information on fiber blankets for tanks and ovens and in piping, cement, fiber felts and boards and high temperature blocks. Characteristics of each of the materials are presented on each sheet. Forty-Eight Insulations, Inc.

METERS, CONTROLS

4 **Boiler Water Level Control**—Bulletin 465 is this company's latest edition of its data booklets on control in specific installations. This particular booklet describes the boiler water level control of West Reading Station of Metropolitan Edison Co. Excellent photographs of the installation are given and tabular material covers significant data. Sectional views through the high-pressure extension and of the high-pressure boiler are given. Other illustrative material consists of eight records and charts which have been reproduced to indicate the manner in which the control was maintained. Northern Equipment Co.

5 **Liquid Flow Measure**—Bulletin No. 210 describes this company's new parabolic flume for measurement of water, sewage and industrial liquids through partially filled pipes. The bulletin describes the operation of the flume, pictures it and presents a cross-section showing sediment chamber and cleaning valve. A chart shows the theoretical rating curve of a 12-in. flume. Four drawings presented show a typical installation of the flume meter and method of mounting in a manhole. Description of method of installation also is given. Tabular material includes capacity tables and suggested specifications. Several other drawings show illustrations in various locations. Simplex Valve & Meter Co.

6 **Feedwater Control Data Book**—Bulletin 105-B is a 16-page booklet describing the company's Three-Element Feedwater Control. Besides listing and describing the many advantages of the control the booklet also presents chart records which illustrate operation under difficult conditions. Photographs of detailed parts of the control accompany the descriptive material and aid in a complete understanding of the unit's operation. Lists of users of the control also are given. Bailey Meter Co.

7 **Controls Handbook**—Catalog 600A is a 64-page combination handbook and catalog of automatic controls for industrial applications, heating, air conditioning and refrigeration. Wiring diagrams occupy a considerable portion of the booklet; each of these illustrate various hookups using the company's controls. Complete catalog information on all the controls in the line accompany illustrations of each item. Descriptions of alternating current relays, pressure limit controls, differential pressure controls, vapor vacuum limit controls, and many others are included. Stoker controls, industrial oil burner controls, automatic gas pilot controls, and many controls of this general type are described in the back part of the booklet. Other engineering data presented in this section includes conversion tables, ordering data for special controls, and two full pages of control dimensions accompanied by line drawings. The Mercoid Corp.

8 **Pressure Controllers Data Book**—Bulletin 462, titled "Engineering, Operating and Maintenance Data on Pressure Controllers," was issued recently. Selection charts and capacity tables are provided to guide the selection of equipment for specific applications. Instruction for installation, operation and maintenance are presented in itemized, easy-to-follow sequence. Design features are illustrated in large cross-sectional drawings. Leslie Co.

9 **pH Meter Data**—The operation of this company's line-operated, continuous reading pH meter is thoroughly covered in this 4-page Bulletin No. 3. Advantages and features of construction are clearly shown in the several excellent photographs and the accompanying copy tells of the principle on which the meter works and lists many features. A price list appears on the last page of the bulletin. Macbeth Corp.

10 **Liquid Level Controllers**—Bulletin A-100 is a four-page catalog describing this company's Types G and D liquid level regulators. Excellent cross-sectional views of the units are presented and their operational and constructional features are described. Dimensions, capacities and shipping weights are presented. Stets Company.

11 **Pump Governors**—The complete line of Williams equipment for power plants is described in a 24-pg catalog No. 449. Among items covered are Williams-Hager flanged silent check valves, Williams steam pump governors, steam operated traps, high and low alarm water columns, water gages, safety feedwater regulators. Each product is illustrated and diagrammed; tables show the entire range of sizes and complete specifications. The Williams Gauge Co.

12 **Condensation Meters Bulletin** — A new 12-page Bulletin 35-80B gives complete details on this company's rotary condensation meter; it covers details of construction and installation on seven sizes of meters with capacities from 250 to 12,000 lb of condensate per hour. American District Steam Co.

13 **Instruments Bulletin**—This new Bulletin W1811 lists over 150 different items maintained in stock for immediate delivery. The bulletin lists recording thermometers, pyrometers, pressure gages, volt meters, ammeters and pH recorders. Also described and illustrated are recording controllers, indicating controllers, miscellaneous instruments and accessories. The Bristol Co.

VALVES

14 **Bronze Gate Valves**—This 3 fold folder describes the company's 200 lb union bonnet bronze gate valves. Four figures in the line are described and illustrated. The features of the line—construction of the bodies and bonnets, stuffing boxes, hand wheel and markings—accompany the illustrations. Tables of the dimensions and list prices are given. The Fairbanks Co.

15 **Steel Valves Bulletin**—Form No. 352 is a four-page bulletin which describes the dependability and absolute flow control obtainable with steel valves. A huge sectional drawing of the valve is used as a vehicle for pointing out construction features. Tables of material specifications and service recommendations are given and another table lists prices of the valves. The Ohio Injector Co.

16 **Safety and Relief Valves**—Safety and relief valves to match the improved designs of the latest power and process equipment are announced in a catalog,

POWER PLANT ENGINEERING

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XUM

No. 45, just issued. An easy-to-use pictorial index shows line drawings of all the basic Farris valve types. With this index a valve user can pick out the valve he needs without having to thumb through a whole catalog. Directly opposite the pictorial index is a detailed index showing what the valve can be used for and where to find its specifications in the catalog. Farris Engineering Co

ELECTRICAL

17 Electrical Production — This company's entire line of electrical products for industry is covered in this bulletin Form GU-2. The bulletin opens with several excellent shop views of the equipment in the various stages of manufacture and continues from there with detailed descriptions and photographs of products such as transformers, unit substations, banking systems, etc. In some instances the description of the product is quite complete and detailed and in others the story told about the product is exceedingly brief. However, the bulletin is so profusely illustrated that the photographs tell a large part of the story. One section covers several types of motors—fan cooled, explosion proof, chemical proof, splash proof and open type. Each type has a full page of description devoted to it. Wagner Electric Corp.

18 Intraplant Communication — Intraplant communication is completely covered in a group of folders issued recently. The manufacturer's Operadio Soundcaster, Plant Broadcaster and Flexiphone intercommunication systems are dealt with thoroughly. Typical installations with discussions of the outstanding features of each are included. Principles of operation and details of construction are given and photos illustrate each feature mentioned. Operadio Manufacturing Co.

19 Wiring, Cables—This bulletin is a 36-page data book on the company's line of wire and cables. The complete story of construction, design and specifications is told and many tables are presented to give much engineering information; typical of these tables are those on Insulation Thicknesses and Test Voltages, Insulation Resistances, Insulation Resistance Correction Factors, Series Transformer Ratings and Recommended Thicknesses of Insulation, etc. Excellent photographs show cable and wire construction and each type is well described. The Okonite Co.

PUMPS, COMPRESSORS

20 Compressors, Vacuum Pumps—Bulletin C-5 is a 16-page folder bound in a separate heavy paper cover and it describes the company's rotary compressors and rotary vacuum pumps. Complete details of construction including illustrative material such as photographs of parts of the units and drawings of detailed structural parts are presented. Tables present size and capacity information. Three pages of typical installations are shown and a chart of typical characteristics is given. Fuller Co.

21 Rotary Pumps Bulletin—Bulletin W-484-B1 describes the company's Type GA rotary pumps for general service. A full page listing of the "Services Rendered" (in automobile and aircraft industries, beverage, food products, chemical, etc.) is presented at the start of the bulletin and the catalog then goes on to describe in detail the various parts of pumps and the models available. Considerable tabular material makes the bulletin exceptionally useful; there are tables of typical speeds, capacities, pressures and power requirements, dimensioned drawings and tables of dimensions. Other products are shown on the last page of the bulletin. Worthington Pump and Machinery Corp.

22 "The Hydropress Pump"—Here is a 12-page Bulletin 46-6000 which describes a pump designed for those who have high pressure, low volume pumping jobs requiring maximum efficiency. In three colors throughout the 12 pages, this bulletin covers technical data, application pictures, cross-section drawings of parts, operation and design features, dimensional sketches and assembly procedure. One of the installations featured and pictured in the unusual pump application at the rim of the Grand Canyon where four of these pumps lift water 3200 ft. Byron Jackson Co.

23 Jet Pumps Data Bulletin—A simple, time-saving method of determining the correct type of jet pump for the user's individual requirements is a feature of Bulletin 315. The bulletin details the manner in which this line of jet pumps, utilizing water under pressure as the pumping medium, is used in the transfer, removal or mixing of liquids, heavy sludges, process wastes and fluids containing substances injurious to conventional pumping equipment. Also included are charts and tables to facilitate proper selection over a wide range of conditions. Derbyshire Machine & Tool Co.

COOLING, HEATING

24 Heating, Ventilating, Air Conditioning—This company's products for heating, ventilating and air conditioning which are used in a variety of installations from department stores and office buildings to aviation wind tunnel testing are presented in Bulletin 25B6183. Photographs of installations of motors driving refrigerating machines and large ventilating fans, variable pitch sheaves, centrifugal pumps, various types of motors, transformers and controls are given. Allis-Chalmers Mfg. Co.

25 Unit Heaters — Bulletin 1206, 16-pages, describes this company's horizontal discharge propeller fan unit heaters. Details of construction and a listing of the operating features of the unit are given in the front part of the booklet and the section also includes tables of capacities, dimensions, contents and forced hot water capacities. Other tables give information on the constant speed or variable speed motors used with the unit heaters. The bulletin also covers the line of unit heater controls which includes thermostats, limit controls and manual starters. Other tabular material which should prove of usefulness to the engineer includes tables of heat transfer coefficients, coefficients for flat roofs, coefficients for concrete construction, coefficients for frame construction, diagrams of unit heater arrangements and various types of buildings and wiring diagrams are given. A full page of unit heater connections for steam systems adds to the usefulness of the booklet. Airtherm Mfg. Co.

26 Unit Heaters—This 8-page bulletin JS20-10M-016, presents complete engineering data on one series of the company's heavy duty floor type unit heaters. Operating data, motor horsepower and air delivery are listed in tabular material and operating data which includes a complete description of the unit accompanied by line drawings, is given in another section of the booklet. Photographs of the unit installed are presented and line drawings show methods of installing duct work for hangars, factories, and similar structures. Other products in the company's line are briefly described and parts of the floor type unit heater are described in detail. Surface Combustion Corp.

27 Steam Vacuum Refrigeration—This company's equipment for steam vacuum refrigeration is described in Bulletin 868. Instructions on installation of the unit and a list of its operating advantages are given. A large illustration of the equipment is presented in the center spread of the folder. The bulletin points out that this system of refrigeration is simple and reliable, inexpensive to install and operate. Graham Mfg Co., Inc.

28 Heating, Valves, Traps, Controls—The complete line of this manufacturer's heating specialties including venting valves, thermostatic traps, float traps, supply valves, vacuum and condensation pumps, etc., are covered in this new 8-page general catalog. Tables of capacities, weights and sizes are presented and illustrative material consists of line drawings and photographs. Hoffman Specialty Co.

29 Cooling Equipment Guide—The latest guide, No. C.E.47, published on cooling equipment has just been made available by this manufacturer. It embodies descriptions and engineering information on current cooling problems, spray ponds, nozzles, etc. The publication not only includes complete data on all the latest innovations in cooling equipment but also presents a wealth of information of current cooling problems. Santa Fe Tank and Tower Co.

PACKING

30 Packings Folder—Palmetto Pyramid packing is described and illustrated in this four-page folder. The description points out the reasons for the excellent design and construction of the various types of packing and also gives recommendations for service. Greene, Tweed & Co.

31 Packings Catalog—Describing and illustrating the complete line of the company's packings is the purpose of this recently-issued 16-page condensed catalog. Many tables of weights are included in the booklet and service recommendations are given for each type of

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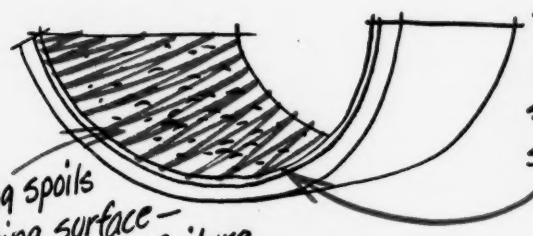
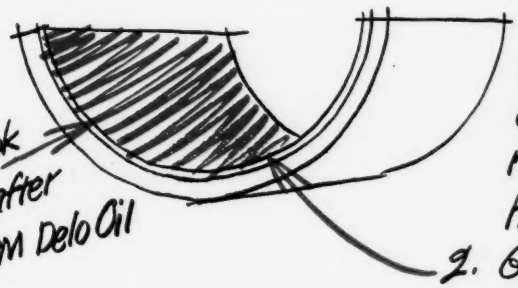
LUBE MEMO

Why it's smart to avoid "metal eating" lube oils



Heat and air in Diesels make many oils corrosive so they "eat" lead from structure of alloy bearings

pitting spoils bearing surface— leads to failure



Joe says bearings look like this after using RPM Delo Oil

1. RPM Delo Diesel Engine Lubricating Oil contains anti-oxidant compound, resists effects of heat and air.
2. Gives bearings direct protection against corrosion.

DIESEL ENGINE RPM DELO LUBRICATING OIL

Note—arrange trial of RPM Delo Oil ... looks like it'll save us $$!

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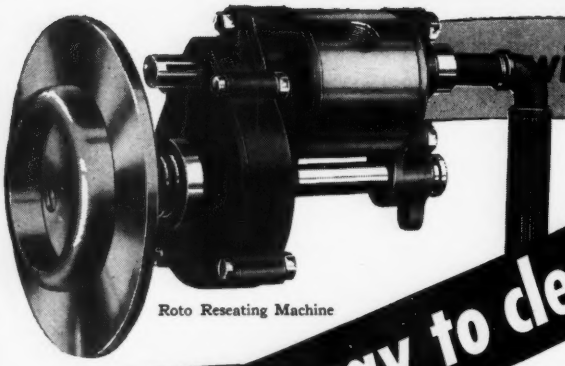
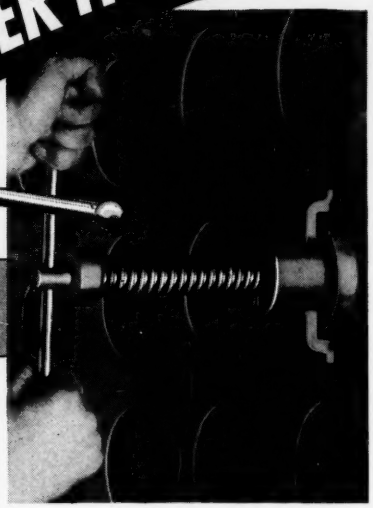
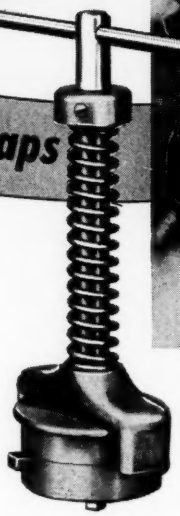
A quick way to clean BOILER HEADERS with outside caps with inside caps



Roto Reseating Machine



Illustrating ease of operation of Roto Hand Hole Seat Scraper



Roto Hand-Hole Seat Scraper for Heine Boiler Headers

Roto offers you a quick, easy means of assuring tight, leak-proof joints between boiler headers and caps. The Roto Reseating Machine removes scale, rust or other adhering matter from headers with outside caps and provides a smooth, true fit.

For boiler headers with inside caps Roto offers a simple hand-hole seat scraper which cleans either round or oval holes. These machines have been used widely for many years, and are sold on a money-back guarantee of satisfaction.

ROTO RESEATING MACHINE

This air-driven machine cleans headers and caps with an abrasive cloth disk fastened to a flat surface plate whose pilot ring accurately centers the disk on the gasket seat. Caps are cleaned by fastening the machine in a vise and holding the cap against the disk. Three pilot rings are furnished; one for the header and two for cleaning both sides of the caps.

The inexpensive abrasive disk is easily replaceable when worn, assuring a true grinding surface at all times. The machine is light (10 lbs) and convenient to handle. It develops 1 hp at 5,000 rpm, and is geared down 5 to 1 to provide ample torque. Send for details and prices.

NOTE—This machine can also be used for cleaning ½" to 1½" condenser tubes by simply removing the surface plate and attaching Roto Extension Shafting with a fluted drill or wire brush.

ROTO HAND-HOLE SEAT SCRAPER

This simple, hand-operated tool consists of a cutting head with retractable cutters, mounted on the end of a revolving spindle having a bearing in a substantial yoke. An adjustable spring automatically maintains tension on the cutters, sufficient to remove all foreign matter but not enough to cut the metal. A few turns to the right and the job is done. A half turn to the left releases the machine.

Roto Scrapers are available for standard round or oval holes. Minor adjustments make them suitable for special sizes or conditions. Write for details and prices.

Make of Boiler	Tube Size	Opening
Babcock & Wilcox	4"	Oval
Babcock & Wilcox No. 40 Header	3¼"	Oval
Babcock & Wilcox No. 41 Header	2"	Oval
Babcock & Wilcox Superheater	2"	Round
Edge Moor	4"	Oval
Heine	3½"	Round
Keeler	4"	Round

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Write for the name of your nearest Tube Turns distributor, and for facts about how the fittings that become part of the pipe serve others in your industry.

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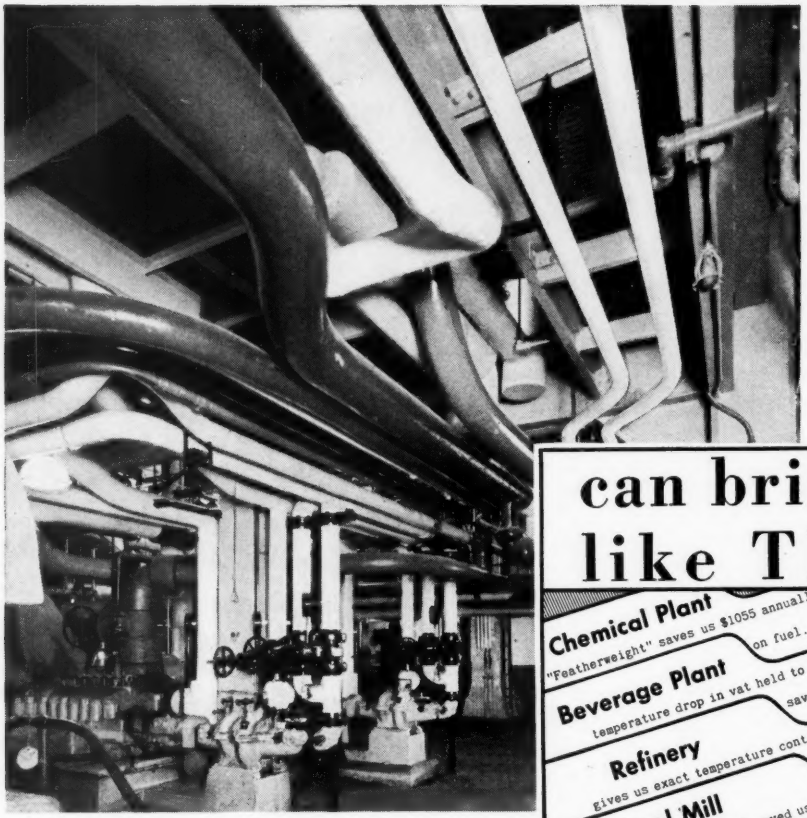

Condenser room of a large midwestern utility. As is customary in many plants, some of the lines have been painted to identity service.

can bring results like THIS . . . .

Chemical Plant
"Featherweight" saves us $1055 annually on fuel. We are very pleas

Beverage Plant
temperature drop in vat held to 19° in 64-hour weekend shutdown, saved us considerable time and fuel when we resumed.

Refinery
Gives us exact temperature control, enormous fuel savings. In our plant this is a matter of vital concern.

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"Featherweight" saved us $1750 in one month. We expect to find similar savings in the months and years to come.

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perature drop in vat he
ved us consi

K & M "Featherweight" 85% Magnesia

Closeup view of K & M 85% Magnesia Insulation, complete with Canvas Jacket, on portion of piping.

You're sure to lower your fuel consumption, increase efficiency when you specify K&M "Featherweight" 85% Magnesia Insulation. You have more than just our word for it . . . actual performance under a wide variety of service conditions has *proved* "Featherweight" to be the most efficient insulation of the moulded type, for temperatures up to 600°F.

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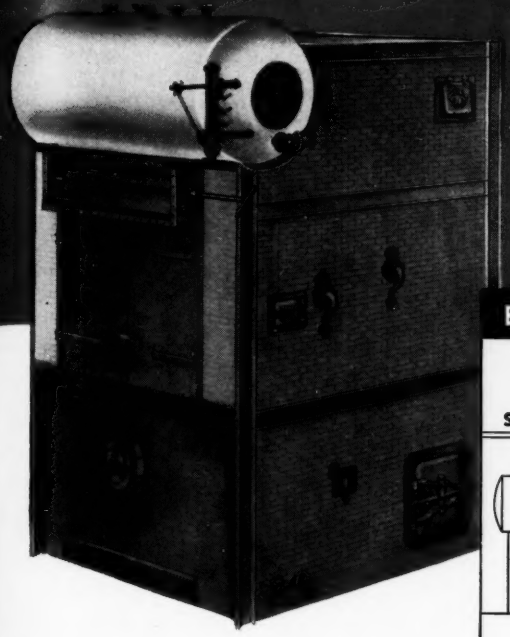
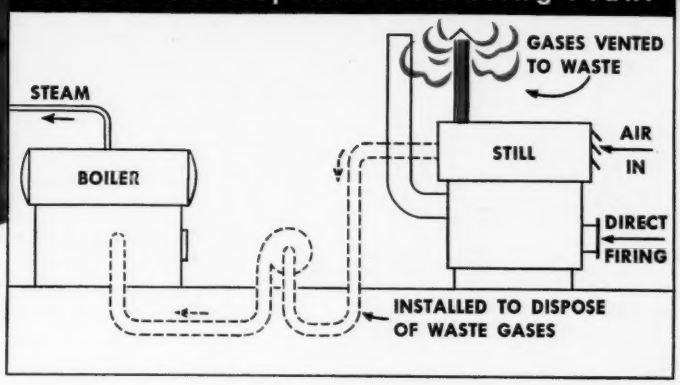
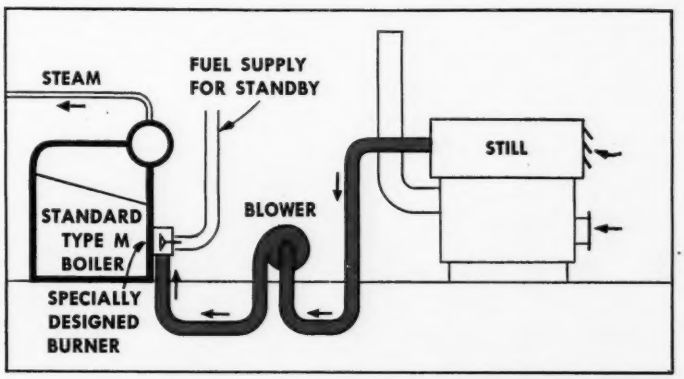
Special Requirements!



EXAMPLE: Asphalt Processing Plant



OLD — This simplified schematic diagram shows the original hook-up used by a processing plant in reducing heavy petroleum base stock to asphalt. Complaints about the odor of the waste gases led to their being piped to a boiler (dotted lines) where partial burning resulted.



NEW — Springfield Boiler Co. engineers, called in on the job to make recommendations on a new boiler plant, found that an arrangement could be provided, in conjunction with a Springfield Type M Standardized Boiler, whereby virtually all of the heat content of the waste gases would serve a useful purpose in firing the new boiler. As a result, fuel costs are lower and complete waste disposal is accomplished.

Do YOU need a special boiler? If it is a matter of getting early delivery at a reasonable cost, don't overlook the opportunities offered by the Springfield line of standardized Type M boilers. With component parts for a range of sizes in stock ready for finishing and assembly, Springfield is breaking many accepted customs in meeting early shipping dates and in giving customers boilers that meet specific needs. This is the result of the adaptability of the basic design, plus the broad experience of Springfield engineers in developing modern steam generators for every branch of industry. For information and recommendations, see your local Springfield Representative, or write.

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1951 E. Capitol Ave.
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STEAM GENERATING UNITS

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ANY SIZE ANY FUEL ANY PRESSURE

XUM

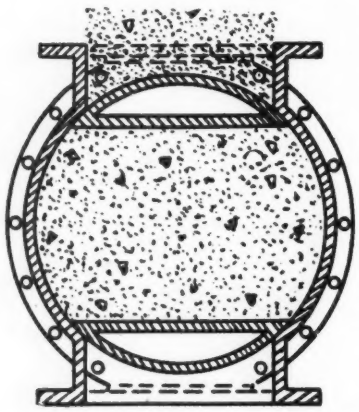
NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Illinois.

A Aluminum Alloy Rotary Gates

Beaumont Birch Co. announces the incorporation of an aluminum alloy in the construction of rotary gates for use in the handling of bulk materials. Proven in service, these gates have been available in cast iron and, in recent years, in stainless steel.

They are designed for use with very fine materials (soot and fly ash, cement, etc.). The gates are quick acting, totally



enclosed and dust tight. Unrestricted flow of material is assured by making the rotor opening pipe size. Even when the gate is plugged full, it can be operated without strain or difficulty since the material merely revolves in the gate rotor. The material need not be displaced to close the gate.

The simplicity and balance of the rotor construction permit use of the gates at any angle and removal of the rotor without disturbing body connection to chute, hopper or bunker.

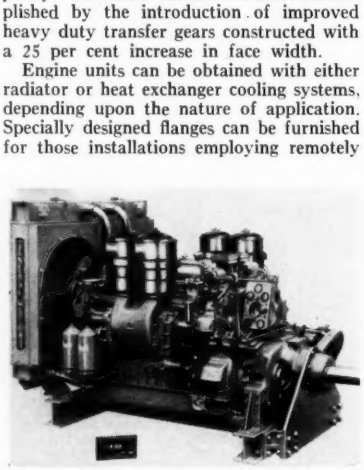
B Diesel Engine Line

This new Series 71 "Twin 6" Diesel engine line has just been announced by Detroit Diesel Engine Div., General Motors Corp. Each Twin unit is made up of two basic 6-cylinder 2-cycle engines mounted side by side and geared to a single shaft. Units are offered with either right or left-hand rotation. Continuous bhp at 1800 rpm is 276 with maximum intermittent rating of 400 at 2000 rpm.

Probably the most outstanding feature of the new models is the variety of power take-off arrangements that are being made available. Versatility is the keynote. Any one of four different transfer gear types can be selected as follows: 1) The H.D. or heavy duty power take-off has been designed to take pulley and chain drive side thrust without the need for a special cradle-mounted sheave or sprocket. 2) The S.S. or Stub Shaft "fills the bill" with any of the various types of couplings encountered with heavy duty machinery. 3) The D.F. or Drive Flange is available for installations where the driven machinery is to be connected directly to the power unit. 4) The O. H. or S.A.E. "0" size housing has been designed to support any close coupled power take-off within the proper horsepower range. Particular attention has been given to its application with torque converters.

Gear ratios of 1:1 direct drive, and 1.33:1, 1.77:1, and 2:1 reduction are available with each of the four transfer gear types. An increase in the shock load capacity over earlier models has been accomplished by the introduction of improved heavy duty transfer gears constructed with a 25 per cent increase in face width.

Engine units can be obtained with either radiator or heat exchanger cooling systems, depending upon the nature of application. Specially designed flanges can be furnished for those installations employing remotely located radiators or cooling towers. Commensurate with the general aim of increased sturdiness, the engine base has been provided with stronger "I" beam supports. These are so arranged as to facilitate removal of one or both of the engines.



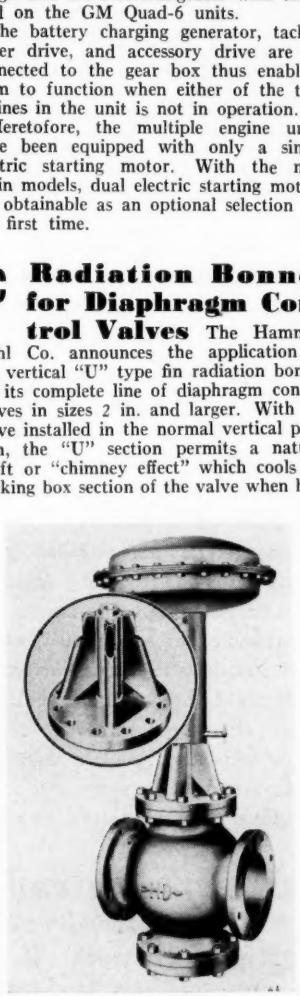
Throttle controls have improved bearing areas and are of much more rugged construction throughout. Component parts of the throttle mechanism follow the same design and are interchangeable with those used on the GM Quad-6 units.

The battery charging generator, tachometer drive, and accessory drive are all connected to the gear box thus enabling them to function when either of the two engines in the unit is not in operation.

Heretofore, the multiple engine units have been equipped with only a single electric starting motor. With the new Twin models, dual electric starting motors are obtainable as an optional selection for the first time.

C Radiation Bonnet for Diaphragm Control Valves

The Hammel-Dahl Co. announces the application of the vertical "U" type fin radiation bonnet for its complete line of diaphragm control valves in sizes 2 in. and larger. With the valve installed in the normal vertical position, the "U" section permits a natural draft or "chimney effect" which cools the packing box section of the valve when high



temperature fluids are being handled The natural convection currents plus radiation made possible by this type of construction effectively reduces packing box temperatures. This permits efficient use of the proper type grease seal lubricant in the grease ring of the packing box. Tests indicate 35 per cent better heat dissipation than conventional horizontal fin designs. This greater efficiency in dissipation of heat from the packing box section is obtained regard-

POWER PLANT ENGINEERING

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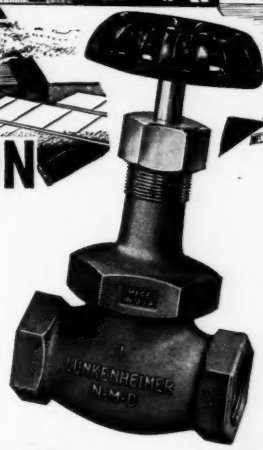


Fig. 123 "N-M-D" Globe

Fig. 1430 Iron Body Gate

Fig. 2125 Bronze Gate

LUNKENHEIMER VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S. P.; BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS

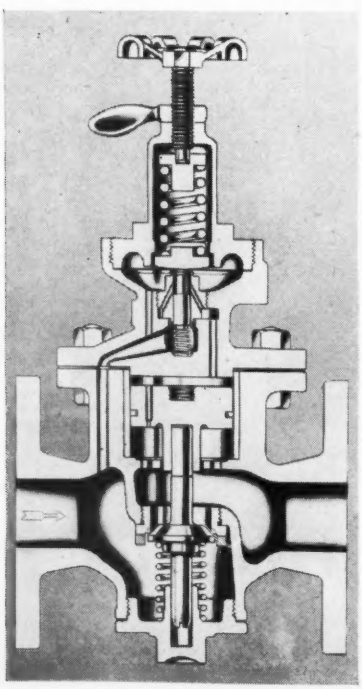
less of whether the control valve is mounted vertically or horizontally, due to the larger effective area provided by this type of radiation bonnet.

Because the "U" fins are fabricated integrally with the forged bonnet, they provide the strongest possible structural support for the all-steel superstructure. No additional structural support is required for a Hammel-Dahl valve even though the valve is installed in the horizontal position.

Radiation fin bonnets should be applied to all control valves when the temperature of the fluid passing through the valve body is in excess of 450 F. Extension bonnets are also required on control valves when handling fluids at temperatures below the freezing point. The vertically finned radiation bonnet is equally satisfactory for low temperature applications, as its central section is tubular and of exactly the same section as would normally be used in an extension type bonnet. The usual horizontal fin construction "ices" progressively at extremely low temperatures until the packing box and stem become frozen solidly. Under these conditions the control valve becomes inoperative. This does not occur with the vertical "U" fin type.

When the vertical "U" fin radiation bonnet is applied to stainless steel or alloy valves, a stainless steel tube and disc of the specified type is retained by a carbon steel housing. Thus all parts of valve wetted by the fluid are provided in the specified material, yet we have the efficiency of the "U" fin to dissipate heat and provide structural support.

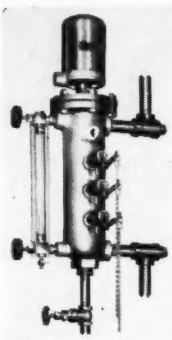
D Overflow Valve Throttling type unloading valve, class UL, for use with steam, air or gas has been announced by Leslie Co. This valve is applicable wherever a throttling type regulating valve is required to maintain a constant inlet pressure by relieving the excess to a lower pressure system. A feature of the operation is smooth throttling control during the entire cycle of operation combined with quick action under sudden pressure variations.



Construction features include high pressure bronze body, renewable wearing parts, hard surfaced seat ring, hardened stainless steel main and controlling valves, bronze piston, corrosion resistant piston rings, phospor bronze diaphragm.

Available in sizes from ½ in. to 4 in.; for inlet pressures from 25 to 300 psi, inlet temperature to 550 F and pressure difference not less than 15 psi.

E Boiler Water Level Control Magnetrol, Inc. announces a new boiler water level control which, through a simple magnetic switching action provides a dependable method of pump control, low water fuel cut-off, and low water alarm. This new control transmits changes in water level to the switching mechanism by magnetic action. There is no mechanical or electrical connection between the pressure chamber and the switching mechanism.



The new Models No. 126 for pressures up to 125 psi and No. 251 for pressures up to 250 psi feature the Type S "Unitary" switching mechanism which is completely self-contained with mercury switch, magnet, lead wires and terminal strip built into a single unit for simple installation and easy servicing.

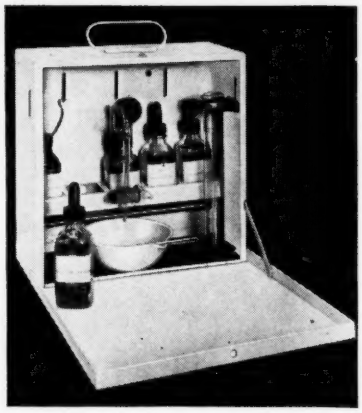
F Test Kit For Controlling Carry-Over An ingenious testing unit is the latest contribution of TruTest Laboratories, Inc., to easier, more accurate and more readily applicable on-the-job analyses of water conditions.

The compact metal cabinet contains all the apparatus and standardized chemicals needed to make accurate chloride determinations and insure constant carry-over control for marine and stationary high pressure boilers.

The cabinet is made of adequately heavy gauge steel with a white, acid-resistant finish inside and out. The unit can be easily carried by its folding bale handle, or hung at any required location by the slotted holes in the back wall. The cover, when opened, provides a rigid working shelf which also contains full operating instructions. The overall weight of the kit is approximately 7 lb.

Determinations by this kit are easy to make. A 100 ml. sample of the water to be tested is obtained by pouring two 50 ml. portions, measured in the 50 ml. cylinder, into the casserole. Six drops of phenolphthalein indicator are then added to the sample. If the sample turns pink (indicating alkalinity), 5 per cent sulfuric acid is added, drop by drop, until the pink color disappears. Then ten drops of potassium chromate indicator are added, which turn the sample a bright yellow.

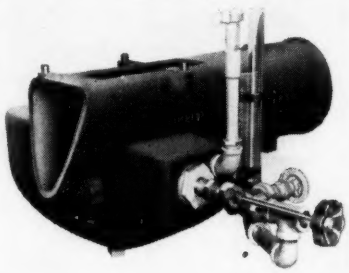
Now N/25 silver nitrate is slowly added, drop by drop, with constant stirring of the sample, from the specially designed automatic micro-burette until a slight orange red color develops throughout the sample. This is the end point. The brick red color resulting from adding more silver nitrate gives a reading past the end point.



Results are read directly from the burette in grains per gallon. For example, if a 100 ml. sample requires 0.4 ml. of N/25 silver nitrate to develop the slight orange red color of the end point, the chloride content of the water is 0.4 gpg.

G Parabolic Flume This Type S parabolic flume was announced recently by Simplex Valve & Meter Co. It is designed specially to measure accurately flows of all kinds of liquids through partially filled pipes, sewers or channels where free-flowing conditions exist. It is constructed of cast iron with standard spigot inlet design at its circular upstream end. Bell or flanged end construction is optional.

The interior of the flume presents a smooth transition from circular to parabolic form, having a straight invert and completely free from pockets or obstructions that might prevent free flow. It is provided with ample-size openings at the top to facilitate easy inspection and cleaning. Cast integrally with the flume section is a sediment chamber with a bronze-bushed piezometer hole leading to the interior of the flume. The flume is available in ten sizes, from an inlet diameter of 6 in. to 36 in. and capacity from 10,400 to 19,070,000 gpd.

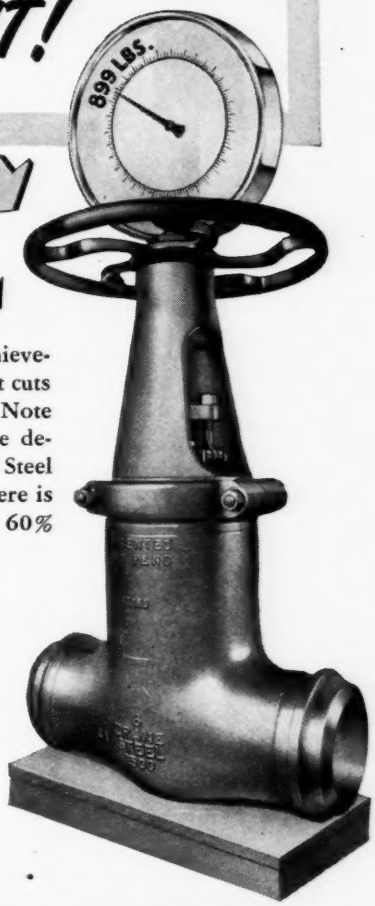


H Soot Scraper This new Mohawk power-driven soot scraper has been considerably improved according to an announcement from the manufacturer. Bearing housings are of a new type

40 to 60% LESS WEIGHT!

New CRANE PRESSURE-SEAL BONNET VALVES

The scales show this weight-saving achievement . . . with no loss of strength . . . that cuts piping erection and maintenance costs. Note comparative weights of this new Crane design and the conventional 1500-Pound Steel Gate Valve, both 8-inch. Size for size, here is amazing weight-reduction . . . 40% to 60% . . . depending on size.



OTHER BASIC ADVANTAGES OF THIS NEW PRINCIPLE

1. *Eliminates Bonnet Joint Leakage*
2. *Ends Bonnet Joint Maintenance*
3. *New Streamlining . . . inside and out*
4. *New Ease of Inspection*
5. *New Ease of Operation*
6. *Improved Flow Characteristics*
7. *Reduced Over-all Dimension*

REVOLUTIONARY DESIGN IN STEEL VALVES FOR HIGH PRESSURES AND HIGH TEMPERATURES

No valve improvement in a quarter-century compares with the Pressure-Seal Bonnet principle. It completely eliminates the customary flanged bolted bonnet joint with its problems of leakage and maintenance. The joint is inside the valve—automatically sealed by fluid pressure. This new principle, as applied by Crane, brings a whole new set of standards for on-the-job valve efficiency.

The Crane Pressure-Seal line includes gate, globe, angle, and automatic stop-check patterns with welding ends. Complete information regarding performance and adaptability to your requirements supplied on request.

1500-Pound Crane Pressure-Seal Bonnet Globe Valve

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas.

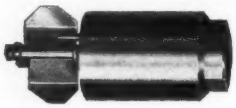
EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

which keeps the ball bearings in the proper position at all times by preventing slippage in any direction; these bearings are shielded with the result that no lubrication is necessary. It is pointed out that this simplifies the operating hook-up as there



is no need for placing a lubricator in the power line.

Motive power is either steam or compressed air. Extremely rapid action of the blades is described as making possible a fast, thorough job of removing soot from the inside of the tubes and the slag and incrustation is blown out of the tube by the steam or air exhausting from the scraper. Brunt Equipment Co. makes this soot scraper.

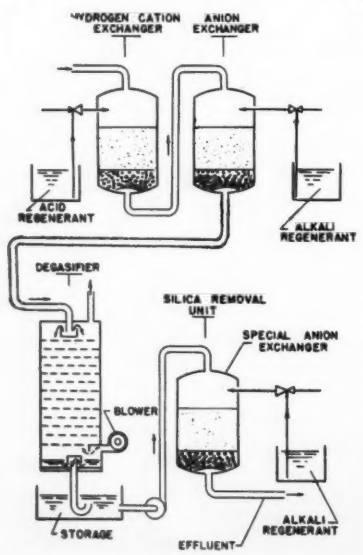
J Silica-Removal Units

Liquid Conditioning Corp. announces its development of equipment which applies the principles of demineralizing to the removal of silica from raw boiler feedwater.

This new development employs a standard demineralizing plant, consisting of a hydrogen zeolite unit followed by a Liquon anion exchange unit. To effect the elimination of silica, a fluoride such as sodium fluoride is added to the raw water entering the hydrogen zeolite unit. Here, the fluoride is converted into hydrofluoric acid by a resin type of acid-regenerated cation exchange material known as Liquonex CR. The hydrofluoric acid combines with the silica to form fluorosilicic acid while, at the same time, the Liquonex CR converts the raw water hardness into the acids corresponding to the salts which are present.

In the second stage Liquon anion exchange unit, the fluorosilicic acid together with the acids formed from the hardness in the raw water are removed by Liquonex A, an alkali-regenerated anion exchange resin of high capacity.

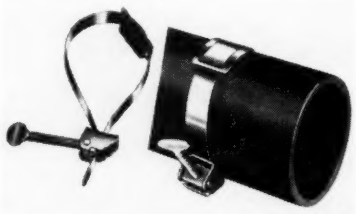
This process therefore removes both silica and hardness from the raw water. In a modification of this process, the silica is removed without the addition of fluorides, by means of a special anion exchanger following the standard demineralizing equipment.



K Pipe Leak Clamp

A new all-purpose pipe leak clamp called the Patchmaster has been announced by Marman Products, Inc. The versatility, ease of installation and durability of the Patchmaster indicate wide application in such fields as power production, water supply, etc., where extensive piping of liquids and gases is common. To all of these the Patchmaster affords a simple permanent method of sealing pipe leaks and a consequent saving in time and money.

The Patchmaster is designed to stop



leaks on pipe ranging in size from ½ in. to 4 in. in diameter. It consists of a corrosion-resistant, stainless steel clamp and specially designed patch plate of stainless steel annealed sheet which naturally forms to pipe contour, and a Hycar oil-resistant pad. When installed and clamp is tightened, pressure is brought against the pipe, positively sealing leak.

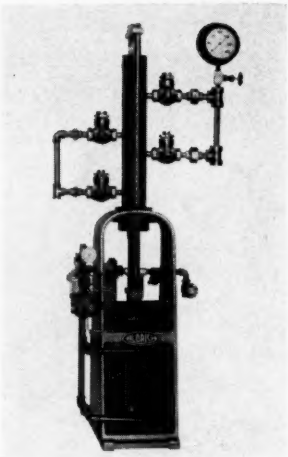
Patchmasters have been tested at 800 psi without leaking. They come in four popular sizes to handle all pipe diameters up to 4 in. and can be used over and over without any efficiency loss. One clamp fits any pipe size up to maximum diameter of clamp.

L New Hydraulic Pump

A new hydraulic pump, the Aldrich-Lytle Hydropneumatic Power Unit was announced recently. This unit, manufactured by the Aldrich Pump Co. is a simplex, double-acting hydraulic pump—powered by air. Engineered and built to provide low volume—high pressure service, it is simple, economical and highly efficient. Both initial and operating costs are lower than for electric or motor driven units and troubles with "wire drawing" through relief valves, as well as the need for constant adjustment, are entirely eliminated since the pump stalls when the desired hydraulic pressure developed corresponds to the air pressure used. Pump delivery is not displaced through a relief valve—the relief valve on this pump being located in the air supply line.

Power is derived from plant air pressure or, if this is unavailable, from a small commercial air compressor. Various pressures can be obtained by simple adjustment of the self-contained air pressure reducing valve. Hydraulic pressures can be maintained without the need for control devices or by-pass valve.

The unit is operated by a vertical double-acting air cylinder and piston that is direct-connected to the upward-acting pump plunger and yoke-connected to the downward acting plunger. The pump cylinders are opposed and are of integral construction. On hydraulic demand, pump

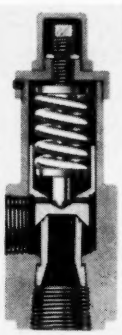


starts to operate and continues until total pressures in air and hydraulic sides equalize.

Because any pressure up to capacity can be selected by adjustment of the air pressure reducing valve, this pump is particularly applicable to hydrostatic test service for various numerous hydraulic pressures. "Wire drawing" through relief valve and other complications — encountered when using constant speed motor driven pumps —are eliminated. Automatic halting of pump operation, when desired hydraulic test pressure is reached, saves power. Pump will operate at a speed sufficient to compensate for any leakage that may occur. Data sheet 69, describing this pump, will be sent upon request.

M Safety-Release Valve

Farris Engineering Corp. has introduced a new and simplified relief valve for pressures up to 10,000 psi. The valve is fabricated completely from bar stock, either bronze, cold rolled steel or stainless steel depending on the service for which it is intended. In either case the disc and nozzle are of stainless steel.



Available with or without test gear, in 3 body sizes—½ in., ¾ in. and 1 in.—interchangeable nozzle inserts provide for proper capacity at set pressures in 3 ranges—2,000, 5,000 and 10,000 psi for each size. This versatility permits application in a wide variety of services.

Exceptionally high flow efficiency, with a coefficient approximating unity, is obtained by virtue of the high lift of the disc brought about by the high kinetic energy of the discharge developed by the venturi action of the nozzle.

By sound basic design and simplification of construction, a noteworthy reduction in the number of parts normally required in a valve for such services, has been achieved. The top-guided disc piston with its 2-point bearing surface is completely free acting. Both bottom inlet and side outlet connections are tapped directly in the valve body. High carbon steel load-

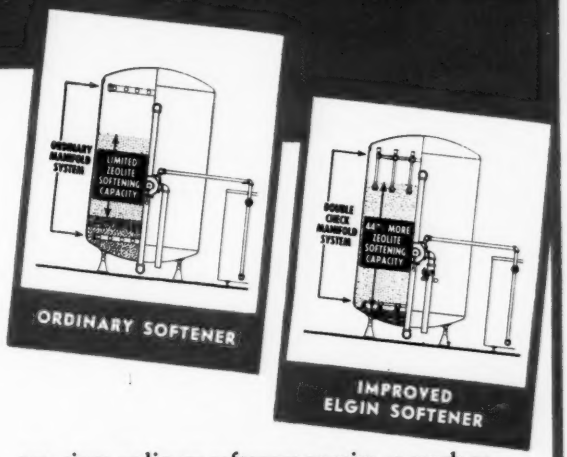
SEE FOR YOURSELF!

. . . how Elgin has revolutionized water softening

Prior to introduction of the improved Elgin, all zeolite water softeners were built basically like the ordinary unit here diagrammed. Note how the zeolite bed — the part that actually does the water softening — is comparatively shallow. This, in reality, was a compromise adopted as an attempt to limit the escape of zeolite during backwashing.

But now see how the present-day Elgin has changed the picture. By perfecting a new manifold system that prevents the escape of zeolite mechanically, Elgin has made it possible to utilize a far deeper zeolite bed. Coupled with the more efficient water distribution and zeolite regeneration made possible by this "Double-Check" Manifold, this deeper zeolite bed produces up to 44% more soft water output than can be delivered by an ordinary water softener of equal size. And this "Double-Check" principle is an Elgin development, fully protected by patents.

Obviously, in terms of soft water delivered, the Elgin way can reduce your original investment. It provides a more compact installation,



too, since ordinary softeners require as much as 50% more space. And it keeps on saving over the years. The more thorough backwashing of the "Double-Check" system produces more zero-soft water per pound of salt, and keeps zeolite clean and active during a longer life. Prevention of zeolite loss means further economy.

Modernize old softeners, too

Your old softener, no matter what make, can be stepped up this new Elgin way. The "Double-Check" Manifold plus Elgin High Capacity Zeolite can mean as much as 44% more soft water output, at surprisingly low cost.

THE IMPROVED ELGIN GIVES 44% MORE SOFT WATER

The whole story is told in a new Bulletin that you will want to read. Ask for Bulletin 607. For hospitals, request Bulletin 608. For laundries request Bulletin 609.

Not all Elgin developments are outwardly as sensational as that described above, but the Elgin solution to *any* water conditioning need is equally direct and effective. It may be along mechanical lines. It may be along chemical lines. *But* in any case it will be along the straight line to low cost, trouble-free water conditioning. There is an Elgin engineer nearby who would like the opportunity to prove this.

ELGIN SOFTENER CORPORATION

136 N. GROVE AVENUE, ELGIN, ILLINOIS

SOFTENERS ★ FILTERS ★ WATER TREATMENT ★ BOILER WATER CONDITIONING

ing spring is completely enclosed and protected. Nozzle seat is well above the drain line, hence remains dry and is not subject to accumulations of scale or sediment.

With these features the valve has proved to be singularly free from maintenance problems and can be depended upon to function properly at all times with no more than the periodic safety inspection.

N All-Purpose Draft Gage

Bacharach Industrial Instrument Co. has introduced a new, all-purpose draft gage, Model MZF, that can be used on every type of heating plant. This gage is supplied with 9 ft of rubber tubing and a 5-in. metal sampling tube. It can be used for readings at the point of draft measurement, or placed any distance away from the test point. It can be quickly and easily mounted on a panel, or if desired, hung on a wall or simply set on any flat surface.

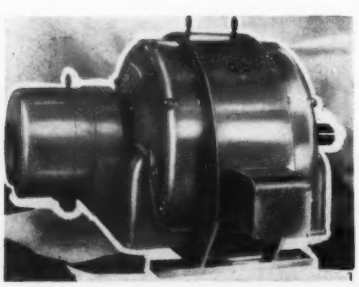
Among the design features of the Model MZF draft gage is an exceptionally large

area diaphragm enclosed in a metal housing, which assures sustained accuracy and trouble-free service. Other practical features include: a distinctive 3 in.-wide scale which can be read accurately and easily even in dim light; zero adjustment can be made without removing any parts; self-contained and compact—dimensions 4¾ in. wide by 7½ in. high by 3 in. deep.

The 0.25 in. range illustrated is now in production. Other ranges will follow.

O Splash-Proof Synchronous Motors

Newly available "heavy-duty" synchronous motors for constant-speed drives up to 1000 hp are available in splash-proof construction often desired in paper mills, chemical plants, mining and milling operations, and for pumping jobs. They are announced by Electric Machinery Mfg. Co.



Stator frame is steel-strong without excessive weight. Brush inspection and blowing out is simplified with access plates designed for speedy removal and replacement. Sealed bearings can be cleaned and refilled without motor disassembly. Double-end ventilation is provided by a blower on each end of the rotor. Exciter also is fitted with blower.

Available in unity or leading power factor, with torque and kva requirements to suit the job.

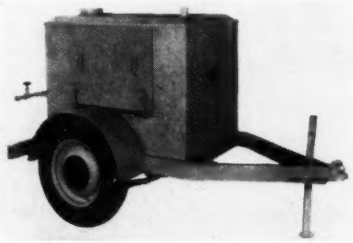
P Steam-Cleaning Unit

The new, improved Oakite-Vapor Steam Cleaning Unit, for use in cleaning and paint-stripping a wide variety of industrial equipment and plant facilities, is now available for immediate delivery, announces Oakite Products, Inc.

The unit, an enclosed-coil type, down-draft flame steam generator, delivers a hot vaporized spray in either wet or dry state under pressures up to 200 lb. Unit generates sufficient steam-cleaning pressure to operate two steam guns simultaneously. The improved model is said to incorporate simplified grouping of gages and controls; redesigned piping system; plus a compressed-air valve accessory for two-minute anti-freezing of the entire water-steam system. 12-gal capacity of the fuel tank provides ample steam generation for an uninterrupted eight-hour, two-gun cleaning cycle.

After initial throttle setting, unit operation is completely automatic. Patented, down-draft flame in triple-insulated fire chamber provides rapid, economical steam generation (100 lb in one minute). Standard dual-chamber steam gun is furnished with the unit; the cleaning solution is aspirated through the gun from a separate solution tank, by-passing the steam coils and totally eliminating coil-clogging by the cleaning compound. Ample reserve power of the unit provides silent, vibrationless operation.

According to service records, the company reports, the new trailer-mounted



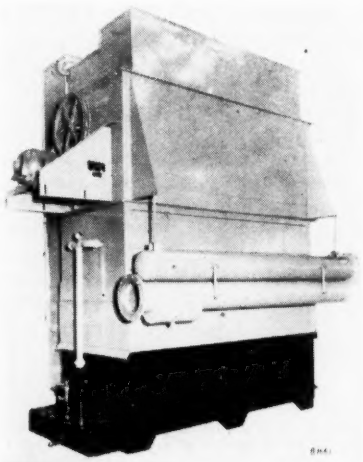
steam cleaner has been used for stripping paint from electrical transformers, both pole-type and underground units; degreasing stationary and portable Diesel engines. General plant maintenance-cleaning tasks are also performed faster with the new unit, it is stated.

It is available as a stationary model; mounted on shop-wheel chassis for around-the-plant portability; or mounted on a trailer-type chassis for use at locations away from shop or plant. A ¾-hp, 60-cycle, 110-220 v a-c motor is rigidly mounted on the unit. For special applications, alternate motive power includes a self-contained gasoline engine, where power source is unavailable, or special ¾-hp motors.

Q Aero After Cooler

Niagara Blower Co. announces an improved design Aero After Cooler for cooling compressed air and condensing and removing the water vapor contained in it. The principle of the Aero After Cooler is the evaporative cooling of the compressed air, accomplished by passing it through coils in a spray chamber where atmospheric air is drawn through by fans, evaporating a portion of the recirculating spray water. 1000 Btu per pound of water evaporated are removed from the compressed air.

In the newly improved equipment greater efficiency is obtained by arranging the compressed air coils laterally across the spray chamber and introducing the compressed air through an oversize manifold located lengthwise on the outside of the casing. The compressed air is withdrawn to the receiver through a similar manifold. The result is to reduce the friction of the



compressed air in the coils and secure greater contact with the evaporating spray, thereby bringing the compressed air temperature closer to the wet bulb temperatures of the atmospheric air.

Since the compressed air temperature reached is always lower than the dry bulb temperature of the ambient air, condensation of water in compressed air lines and tools is prevented.

R Compressors

A complete new line of two-stage, air-cooled stationary air compressors has been announced by the Sullivan Division, Joy Manufacturing Co.

"Unitair" compressors are available in nine sizes with power requirements ranging from 15 to 100 hp and piston displacements from 81 to 590 cfm at 100 lb discharge pressure per sq in., based on 60 cycle motor speeds.

Because of their compact construction and smooth, vibration-free operation, Unitairs require but a small foundation. The costs of installing water-piping and of supplying water for cooling are eliminated as all "Unitairs" are completely air-cooled. They have a wide application as a compressed-air source for small manufacturing plants, in foundries or for stand-by service.

The three standard electric drives include built-in motor, direct-connected motor and V-belt drive. "Unitairs" may also be equipped for use with gasoline or diesel engines.

Some of the outstanding features of these

You Can See for Yourself . . .

WHY the Foster 38-SV Safety Valve is ESPECIALLY SUITABLE FOR

HIGH PRESSURES HIGH TEMPERATURES

Pressures up to 3000 pounds and temperatures of 1200° F. are easily handled by the Foster Type 38-SV Super-Jet Safety Valve—it was designed especially for just these exacting requirements! It's no mere "beefed-up" low-pressure valve—rather it's a basic new design for high-pressure service.

Only the Foster 38-SV Safety Valve gives you all these advantages:

1 . . . ***Exceptional steam economy*** because . . . it reseats as low as 1% below popping pressure . . . reseating is positive; without pounding or chatter . . . blowdown is adjustable from 8% down to 1%.

2 . . . ***Unaffected by temperature changes*** because . . . frame rod construction makes crawl negligible . . . deflector protects spring and rods from escaping steam.

3 . . . ***Maximum protection*** because . . . full opening is practically instantaneous . . . full rated nozzle capacity is available at popping pressure . . . once set under operating conditions, its popping point is constant.

4 . . . ***Positive reseating*** because . . . floating disc design . . . steam-centered piston . . . permanently flat seats.

Specify the Foster 38-SV Super-Jet Safety Valve for the finest in high-pressure protection!

Complete details of the Foster 38-SV Super-Jet Safety Valve, for pressures up to 3000 pounds and temperatures up to 1200° F., are given in Bulletin 25. Write for it today!

FOSTER ENGINEERING Company

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . AUTOMATIC STOP AND CHECK VALVES . . . ALTITUDE VALVES . . . DAMPER REGULATORS . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . LIQUID LEVEL CONTROLLERS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN AND TRIPLE DUTY VALVES . . . VACUUM REGULATORS OR BREAKERS . . . SIGHT FLOW BOXES . . . STRAINERS . . . SAFETY VALVES . . . SIRENS

111 MONROE STREET • NEWARK 1, N. J.

modern compressors include: force-feed lubrication through rifle-drilled oil passages by means of a positive, gear-driven pump . . . "Cascade" oil cooling to reduce oil consumption and oil sludging . . . low-lift, large port-area, direct concentric valves for high efficiency . . . low piston speeds for long life . . . oversize ball-type main bearings for low maintenance . . . four piston rings per piston mounted above the pin for oil economy and for long-lasting, air compression efficiency.

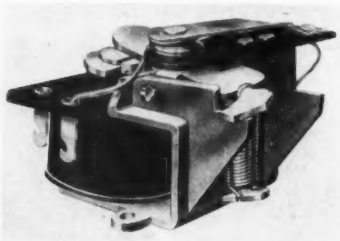
S Small Multi-Breaker To make available fuseless circuit breaker protection to smaller installations and to provide a branch circuit load center for many larger installations, Cutler-Hammer has added a new, small, four-pole Multi-Breaker to its line.

The MO-4 Multi-Breaker combines four breaker poles which can be used as four single pole circuits or—by inserting a simple tie rod—can be converted to one or two double pole, 3-wire solid neutral circuits.

Unusual in a breaker of this size is the two fold protection provided against short circuits and overloads. The MO-4 incorporates both the well known thermal overload protection and additional magnetic protection as an added guard against heavy short circuits.

The new breaker carries a 50 amp maximum solid main rating, with individual single poles rated at 15, 20, or 30 amp.

T Relay The new Bulletin 109 Relay developed recently by Ward Leonard Electric Co. is designed specifically for use with single phase a-c capacitor motors for oil burners, refrigerators, and other applications. Operational difficulties inherent with centrifugal switches commonly used for starting capacity motors are eliminated by this new relay assuring positive and more reliable motor performance. External or remote mounting of the relay is permissible eliminating maintenance difficulties present when sealed capacitor motors with built-in centrifugal switches are used.



Essentially this capacitor motor starting relay is a potential device operating over a wide range of voltages as distinguished from the close differential current type relay. Chatterless relay operation right down to the drop-out point is obtained through its unique magnetic circuit design.

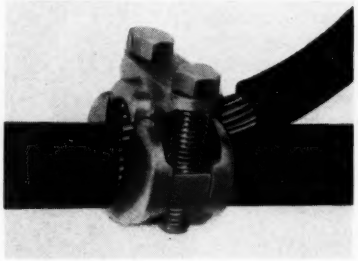
Contacts are single pole normally closed suitable for operation of a load as large as 1 hp, 115 or 230 v, 60 cycle capacitor motor. Bulletin 109 relays though compact in size, are sturdily constructed insuring positive dependable operation over the wide voltage range encountered in starting capacitor motors.

U Cutting Fluid A cutting fluid that combines the three essential requirements of lubrication, cooling, and cleaning, plus gentleness to the hands is announced by The Penetone Co. This product is a liquid concentrate, non-inflammable and non-toxic, which is diluted with approximately 15 parts of water for use as a cutting fluid.

Metal working operations are often slowed up by the need for cleaning off cutting oils after the parts have been machined. With the use of this liquid emulsifier, the additional cleaning step is cut out since the cutting fluid actually cleans the metal as it lubricates and cools. In addition, petroleum base oils are a frequent cause of dermatitis. The new liquid contains no solvents, abrasives, or free alkali and cannot harm the hands. Dermatitis conditions in plants have frequently been cleared up entirely when this harmless fluid was substituted for petroleum base solvents.

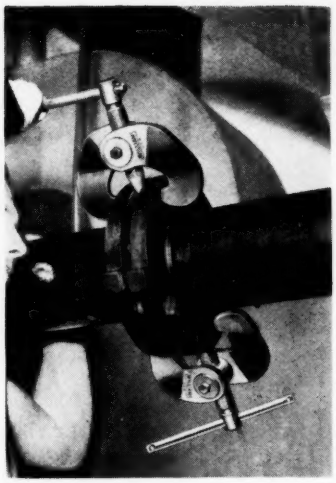
V One-Piece Connector A new one-piece connector designed to fill the need for compact tap connections has been announced by the Burndy Engineering Co.

The connector, Uniklip, Type KOS, has no separate parts to lose. Recessed bolts are built into the rounded, streamlined body, contributing to its compactness and ease of taping. In addition, it is said the generous free swing of the pressure bar and accessibility of bolts from below, further facilitate installation in close quarters.



Uniklip is cast from high conductivity copper alloy and is supplied in five sizes to accommodate all conductors from 4/0 Str. through 1000 Mcm.

W Flange-Jacks For Gasket Replacement The J. H. Williams & Co. line of quality drop-forged tools has been broadened by the addition of the Flange-Jack as a stock item. These fully-patented tools were formerly manufactured by T. G. Persson Co. and have already gained wide acceptance wherever pipe maintenance is a problem.

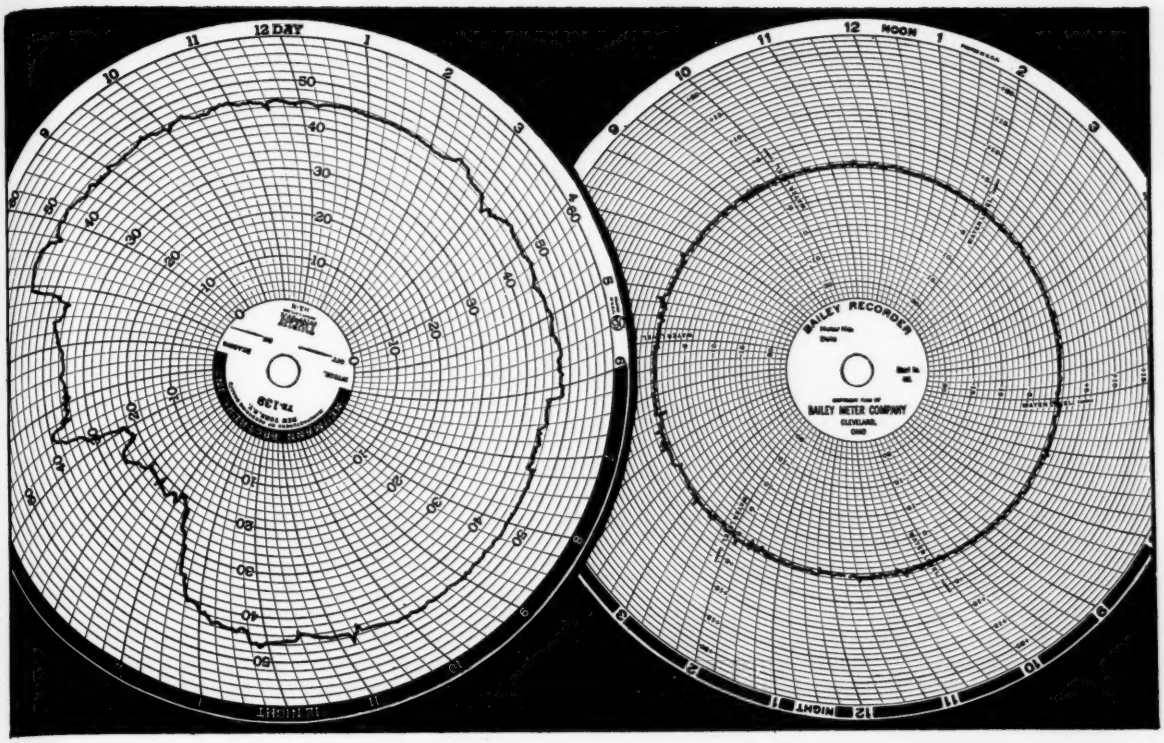


Used in pairs, the Flange-Jack is a tool designed to take the guesswork out of replacing gaskets, regardless of line pressure or location. Flanges are parted quickly and held in perfect alignment without damage to faces. Shock and jarring of pipe lines, danger from flying wedges and sparks caused by hammer blows are all eliminated.

Flange-Jacks eliminate costly shutdowns by making possible fast, economical repairs in hard-to-get-at locations.

X Electrical Symbols Template Rapidesign Inc, offers the new ElectroMaster No. 175 to the power, light and control fields. The ElectroMaster makes every electrical symbol as shown in the American Standards Association manual as well as other accepted symbols.

Made from mathematical-quality plastic sheets, laminated to 0.080 thickness. Inner contours are beveled. Printing is between laminated sheets and cannot wear off. List price is $4.00.



COPES FLOWMATIC CONTROLS

water level within plus-or-minus ½-inch

WITH the load range from a minimum of 200,000 to a maximum of 480,000 pounds of steam per hour on this 675-psi, 900-F Combustion Engineering three-drum boiler, two-element COPES Flowmatic Control is stabilizing water level within plus-or-minus one-half-inch. Feed is divided between two lines, with a relay-operated Flowmatic Valve in each line.

Results have been uniformly satisfactory over the five years since the first COPES Flowmatics were placed in regular service. Three other steam generators in the station have since been equipped with duplicating COPES Flowmatic Control.

The charts above are taken from Bulletin 467, an 8-page performance report on this installation. This report reproduces two other sets of charts, as well as a sectional view of the type of boiler in service and plant photographs. This informative publication is yours for the asking. Write—on your letterhead, please—for a copy.

NORTHERN EQUIPMENT COMPANY

672 GROVE DRIVE, ERIE, PENNSYLVANIA

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters

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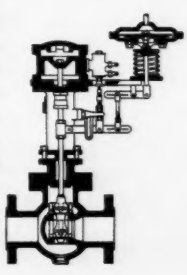

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WHAT LEADERS SAY

Technical Data at Your Fingertips?

By MARGERY BEDINGER

IN THE September, 1946 issue of POWER PLANT ENGINEERING, C. R. Hammond, Librarian of the Naval Ordnance Library in Washington, D. C. pointed out the dangerous fact that valuable information is buried in the mass of technical literature that is being produced faster than libraries can organize it. He instances 440 tons of unclassified reports in two subjects only possessed by one organization alone.

In addition to the amount of material, Mr. Hammond might have mentioned its variety (books, reports, magazine articles, proceedings); and its complexity (meaningless titles, indefinite authorship, unallied subjects treated in the same article). Both of these render the "fingertip" organization of this flood of data difficult and arduous. It is not possible, even if it were desirable, to stop the advance of scientific knowledge and the course of invention, hence this problem is going to get more acute as time goes on. What, then, shall we do?

Breaking our problem down into its component parts, which in this case means into types of material to be made quickly available, we can start with books. They are now cataloged by the Library of Congress. If the cards for them could appear more promptly, and volumes and sets be more fully analyzed, with a bit more accurate subject heading, the information in books would be readily available. There is no real problem here, although it is desirable that the Library improve its service in these ways.

For magazines and society proceedings, various indexes now exist that do excellent jobs as far as they go. The *Industrial Arts Index, Engineering Index* and *Chemical Abstracts,* to name only three, cover the major portion of the important material of this type. The other general and special subject indexes, of which there are scores, catch most of the minor periodical material. If *Engineering Index* were cumulated as *Industrial Arts,* is, if the subject headings of these two library tools corresponded, (standardized terminology), and if the other minor indexes were organized so that duplication were eliminated and their form and subject headings were brought into line with established practice. the great bulk of technical periodical literature would be adequately covered.

Remain then two main types not covered. One of these consists of small news paragraphs in magazines so short as to be frequently omitted in joint indexes; also the stray paragraph or two on a subject hidden in an article dealing with a different subject. This type could rather easily be cared for if the indexes to individual magazines were true subject indexes, such as many books contain, instead of a mere author and title list of main articles, as is deplorably and often the case today.

The other type—and here is the sorest spot in the entire problem—consists of reports, theses, and other specialized material not now included in any of the established indexes. As this type exists literally by the ton, it presents the severest problem. To include this mass of information in the established indexes would render them so bulky as to make them practically unusable. Pages of titles would be included under one sub-head and the person who wanted quick general information would be defeated. Probably there must be special indexes for this type. It usually represents highly-specialized subject matter used by the specialist alone, and therefore well adapted to the special index, with its limited range of inclusions and its highly sub-divided subject headings.

Whether the actual indexing of material at present unindexed should be done by a commercial firm such as H. W. Wilson, which has done such a fine job with the *Industrial Arts Index;* or a group of scientific societies such as publishes the *Annotated Bibliography to Economic Geology;* a government bureau like the U. S. Geological Survey which issues the *Index to North American Geology;*—which one does not matter, so long as it is done efficiently.

The problem resolves itself, in its simplest terms, into a question of more and better indexing. Now what is needed to secure this increased and improved indexing?

Since the problem is fundamentally a library one, there must be an enlarged supply of persons thoroughly trained in the basic library techniques of cataloging, indexing (which is very different from cataloging), classification and subject heading. As the subjects dealt with are scientific and technical, an acquaintance with these fields of knowledge is also a requisite, also a reading knowledge of foreign languages. As everyone knows, only a fraction of scientific discovery and in-

(*Continued on page 77*)

Margery Bedinger is Chief of the Science and Engineering Department of the Denver Public Library, Denver, Colorado, and is one of the leading technical and scientific librarians of the country. In this article, prepared especially for *Power Plant Engineering,* she gives details of the specific methods now used and those still needed by technical librarians to solve the problems of properly organizing our vast and increasing flood of published information. Attention was called to the gravity of these problems by C. R. Hammond, in the September issue. That this is a real and not an invented danger, the editors of *Power Plant Engineering* can attest from their own daily experience.

It is encouraging that many industries and libraries see this and are doing what they can with limited funds and personnel. Several industries are setting up their own library and training facilities. Our own John Crerar Library in Chicago has just announced a special Research Information Service to meet the need.

Following her early training at the Detroit Public Library and the New York Public Library, Miss Bedinger had organized and been head librarian for two years of the technical library of E. I. Dupont de Nemours & Co. at Wilmington, Del.; was the first woman to be head librarian at the U. S. Military academy. She also established and headed for three years the Adult Education Department of the Public Library at Seattle, Washington. From 1930 to 1937 she completely reorganized and built up the library of the Montana School of Mines. In 1937 she assumed her present position. Her department is also the library of the Colorado Scientific Society and the Library of the Colorado Engineers. She holds Professional Librarian's certficates from the States of California and New York. Her standing in the field has recently been attested by an exchange appointment with the head of the Reference Department of the Public Library in Johannesburg, Union of South Africa.

Miss Bedinger graduated with honor from Radcliffe in 1913, has studied and travelled extensively in Germany, Egypt, England, France and Japan, as well as on this continent. She has contributed many articles to the journals of her profession, such as the *Library Journal,* the *American Library Association Bulletin,* the *Wilson Library Bulletin, Mechanical Engineering.* She is a member of the American Association of University Women, American Library Association and others and is secretary of the Denver Altrusa Club.

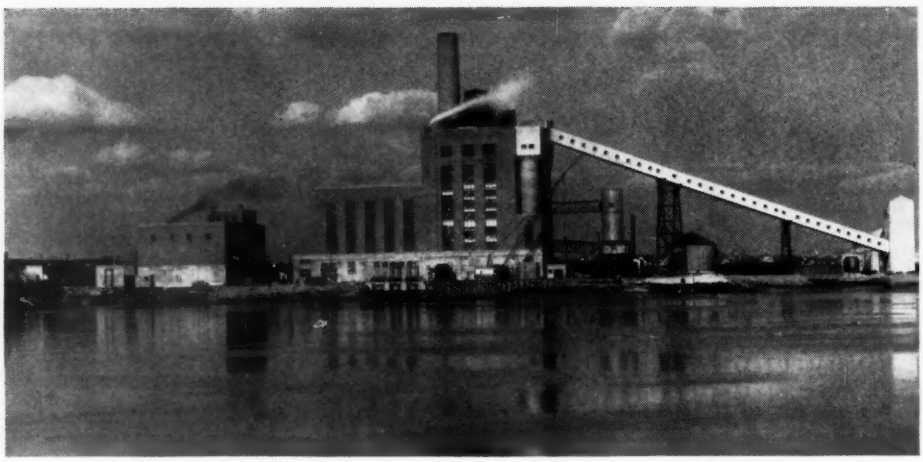


Fig. 1. Mystic Station, Boston Edison Co.

MORE POWER for BOSTON

New 430,000 lb boiler and 62,500 kva generator comprises Unit No. 3 at Mystic Station of the Boston Edison Co. . . . Details of foundations and circulating water pumping system . . . Features of the induced draft fan installation . . . Design of boiler feed pumps . . . Boiler operating experience . . . The new coal handling system uses a shakeout device weighing four tons and operated by 20-hp electric motor

By G. A. ORROK, Jr., Assistant Superintendent of Engineering, Boston Edison Company and **W. P. SAUNIER,** Project Manager, Jackson and Moreland

THE INSTALLATION designated as Unit No. 3 at Mystic Station is essentially the same as Units No. 1 and No. 2, but a discussion of certain variations in the design and some comments on the operating experience at the station seemed likely to be of sufficient interest to warrant the preparation of this article.

The new boiler of 430,000 lb of steam per hour capacity at 1400 psi drum pressure and 910 F total temperature at superheat outlet is virtually the same as the two previous boilers. The boiler is of the three drum type with a suspended economizer of horizontal tubes with longitudinal fins, a regenerative type air preheater and a totally water-cooled furnace fired tangentially from triple element burners in each corner. The burners are supplied by three unit pulverizer mills.

The new turbo-generator of 40,000 kw nominal rating and 50,000 kw capability is the same as the two previous units but has a larger generator of 62,500 kva instead of 50,000 kva rating at 0.5 psi hydrogen pressure. Both new and old generators have 15 per cent more capacity when the hydrogen pressure is raised to 15 psi. The larger generator was provided to enable the station as a whole to deliver its proper share of the reactive load of the system. The generator reflects certain improvements in design since the construction of the previous units, two of these changes being the substitution of vertical hydrogen coolers in place of horizontal coolers and the provision of an improved cooling arrangement in the generator rotor.

Main Building Foundation

The main building housing the boilers and turbines of Units No. 1 and No. 2 is supported on 18 in. OD by 0.5 in. thick steel piles concrete filled and driven through silt, sand, clay and gravel to rock an average of 125 ft below ground and the building basement level. The procedure followed was to drive a 24 in. casing pile 50 ft and to clean out the material within it. An 18 in. pile was then placed inside the casing and driven, after which the 24 in. casing was pulled out. Experience showed no difficulty with these operations and indicated the feasibility of driving 24 in. piles directly from the surface, so the piles for Unit No. 3 were made 24 in. OD by 0.5 in. wall thickness. These larger piles are each good for more than twice the loading of an 18 in. pile and the installation cost per pile is only about 50 per cent greater. A little more than half as many piles are used for Unit No. 3 as were provided for each of the previous units with a resultant saving of about one-third of the piling cost. The 24 in. piles are of spiral welded pipe because this type of material was available. The piles were driven without difficulty and there were no indications of weld failure which might raise the question of the reliability of the material used.

A new screen well house is being installed immediately adjacent to the present structure. The addition is designed to have three intake screens and to house three circulating water pumps, two of them for future larger pumps. Unit No. 3 will be served by one circulating water pump of the same size as the pumps for Units Nos. 1 and 2. The addition was made large enough for three pumps because the increment cost for the added space provided beyond that required for the Unit No. 3 pump was low enough to justify the expenditure at this time even though the building may not be fully used for a decade.

The pump room floor is about 16 ft below mean water level and nearly thirty feet below the ground floor level

on which the motors and switchgear for the circulating pumps are mounted. The pit is kept in a satisfactory condition as far as temperature, moisture and condensation are concerned by the use of a few electric unit heaters equipped with fans. Cork paint on the pump casings and the exposed circulating water pipes prevents condensation of atmospheric moisture on these cold surfaces.

The original screen well and pump house rests on a layer of clay nearly 50 ft below ground level. Some movement of the building was expected, and the circulating water pipes, connecting to the condensers in the main power plant building which is founded on piles driven to rock, had to be designed to articulate and accommodate themselves to the settlement and lateral movements of the building housing the pumps. Periodic checks of the movement of the building made during the construction of the building and during the four years since its completion indicate that movement has been less than expected. The joints in the circulating water pipes have given no evidence of leakage and presumably have accommodated themselves to the movement of the pump house. The new structure is virtually a duplicate of the original one in design and is rigidly connected to it at their common face.

Tunnel from Circulating Pump House to Condenser

For Units No. 1 and No. 2 the circulating water pipes delivering water to the condensers entered the main building at the south or river side and the pipe for Unit No. 2 ran beneath and was suspended from the turbine basement floor. For Unit No. 3 the circulating water conduit runs along the west wall of the main building to the new addition where it enters the building and is carried beneath the basement floor and to the condenser. The new conduit of reinforced concrete is 5 ft 6 in. square inside the corner fillets. It is supported on wooden piles and is provided with articulating joints at the screen well and at its point of entrance to the main station building. Space was provided for this and for the conduits to serve future units when the original plant structures were laid out. The articulating joints are made of five foot diameter cast iron pipes about ten feet long, each end being leaded in a pipe sleeve set in concrete. The joint at the point of entrance to the main building is provided with tie rods at its horizontal center line so that only vertical movement is possible. All of the joints are provided with internal seals to minimize the likelihood of leakage. The articulating joints provided for Units Nos. 1 and 2 have given no difficulty whatever up to the present. Since the period of most rapid movement has passed and since most of the movement to be expected on the joints now in service has already occurred, it seems highly probable that no difficulty need be expected in them. An internal inspection of joints is to be made when next the circulating water lines are drained.

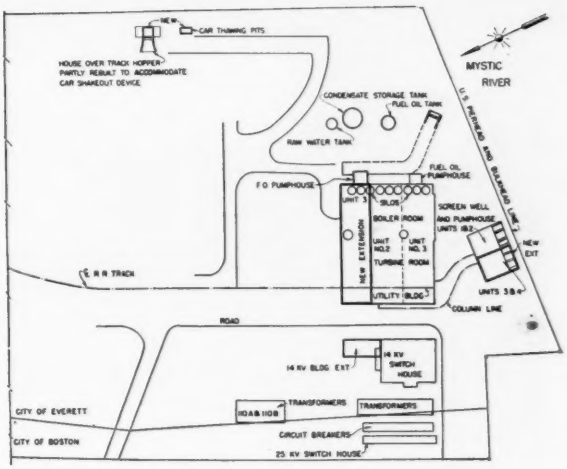


Fig. 2. General plot plant showing the elements of Unit No. 3 heavy outline

Induced Draft Fans

The induced draft fans for the boilers of Units Nos. 1 and 2, located beyond the electrostatic dust precipitators, are driven through variable speed magnetic couplings which have given excellent service. However, a study was made to determine the economic value of the various available methods of controlling induced draft and the induced draft fan for the boiler of Unit No. 3 is to be equipped with variable inlet vane control.

Extensive experience with four different types of induced draft control, all of which operate satisfactorily, provided background for a factual study. The study showed that differences in the total evaluated costs of the various types of control are not great on a percentage basis and that the differences can be influenced markedly by the load factor or manner of operation chosen as the basis for the study. The value of power and the rate at which operating costs are maintained also affect the results of such a study.

The choice was made on the basis of the low first cost of the inlet vane control arrangement and the expectation of operation at a high load factor on the unit for many years. At high fan loads the losses incurred are practically the same as with the variable speed devices. With two units in the station capable of efficient operation at low loads the likelihood of needing to operate the third unit at low loads is small. In order to care for the possible need to operate Unit No. 3 in the future at low loads for extended periods, provision has been made for the installation of a low speed motor of reduced horsepower which will provide for economical operation of the fan in the lower load range.

Boiler Feed Pumps

In common with many other generating plants Mystic Station experienced corrosion-erosion trouble in boiler feed pumps and in feedwater regulating valves. The pumps for Unit No. 1 had impeller volutes and stage diaphragms

As a part of a long range expansion program, early in 1941, the Boston Edison Co. began construction of its Mystic Station. This station was located in Everett on the Mystic River at the point where the Boston elevated crosses the River to Everett and it was built there so as to serve the northern side of the Boston load. As described in the May 1944 issue of POWER PLANT ENGINEERING, the first unit consisted of a 430,000 lb per hr boiler operating at 1400 psi and a 50,000 kva, hydrogen cooled electric generator. This unit went into operation in November 1943. A second similar unit went into operation in the spring of 1945. Recently, a third unit has been added. This, as pointed out in this article by Orrok and Saunier is essentially the same as Units No. 1 and 2 but with certain variations in design based on operating experience with the first two units. It is for this reason that the present article is of particular interest. It recounts some of the difficulties encountered in the operating of the first units and describes the modifications made to overcome these difficulties in the latest unit. The new unit has the same size boiler as the first two units but the generator is rated at 62,500 kva. Data given on fans, pumps, other auxiliaries

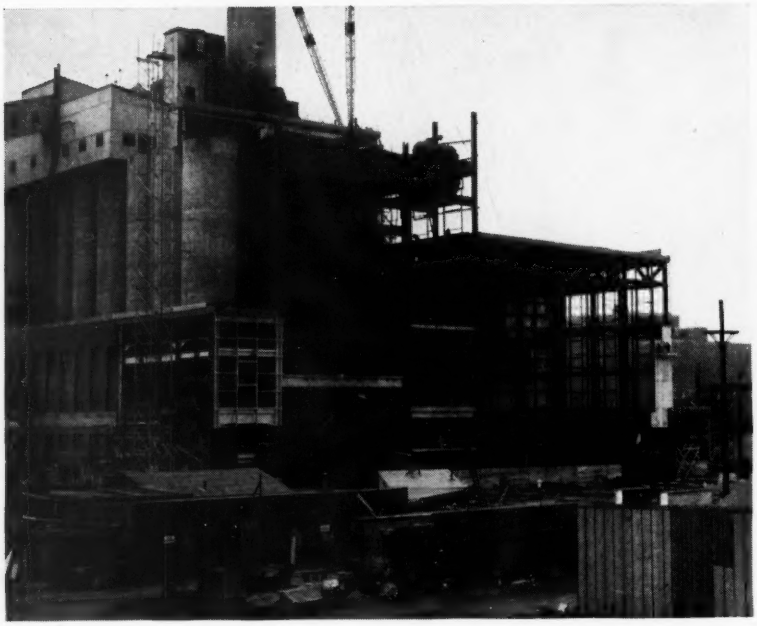


Fig. 3. View showing the third unit under construction. Note concrete coal silos, three for each boiler

of carbon steel which showed marked deterioration after about six months of operation although the pumps were still capable of supplying the boiler. As rebuilt, these pumps have top and bottom half liner castings of 13 per cent chrome steel forming the volutes and stage diaphragms. The liner castings are welded to the upper and lower half casings. The rebuilt pumps have shown no signs of deterioration and no internal wastage of the kind experienced with the original pumps is expected.

The boiler feed pumps provided for Unit No. 2 are barrel type with diffuser vanes rather than volutes. In these pumps 13 per cent chrome-steel was used for all internal parts which are in contact with water moving at extremely high velocities. No internal wastage of metal has been observed and none of the type experienced with carbon steel is expected.

The trouble with the feedwater regulating valves resulted from the wartime necessity of using carbon steel for parts normally made of stainless steel. When stainless steel parts became available the difficulty was eliminated.

Boiler Operating Experience

The boilers installed for Units Nos. 1 and 2 have been in operation since November 1943 and October 1945 respectively. They have performed excellently delivering full rating at guaranteed efficiency and with guaranteed steam temperature. They have ample capacity to operate in excess of the design capacity without slagging at the superheater inlet. Although lancing doors are provided at the superheater gas inlet of each boiler it has never been necessary to resort to lancing at this point or at any point in either boiler. Slag builds up on the furnace tubes and on the screen tubes of the boilers as anticipated, but it is effectively removed by the steam soot blowers at the walls in the boilers. The slag has always been porous and friable and is readily handled.

After about four months of operation a rear water wall tube of Boiler No. 1 failed. The failure was due to clogging of the tube with sediment from the lower drum where a short riser was improperly attached to the downcomer tube which supplied water to the tube that failed and to several adjacent tubes. The downcomer and the water wall tubes it supplied were cleaned out and the riser on the downcomer in the drum was welded in place as were the

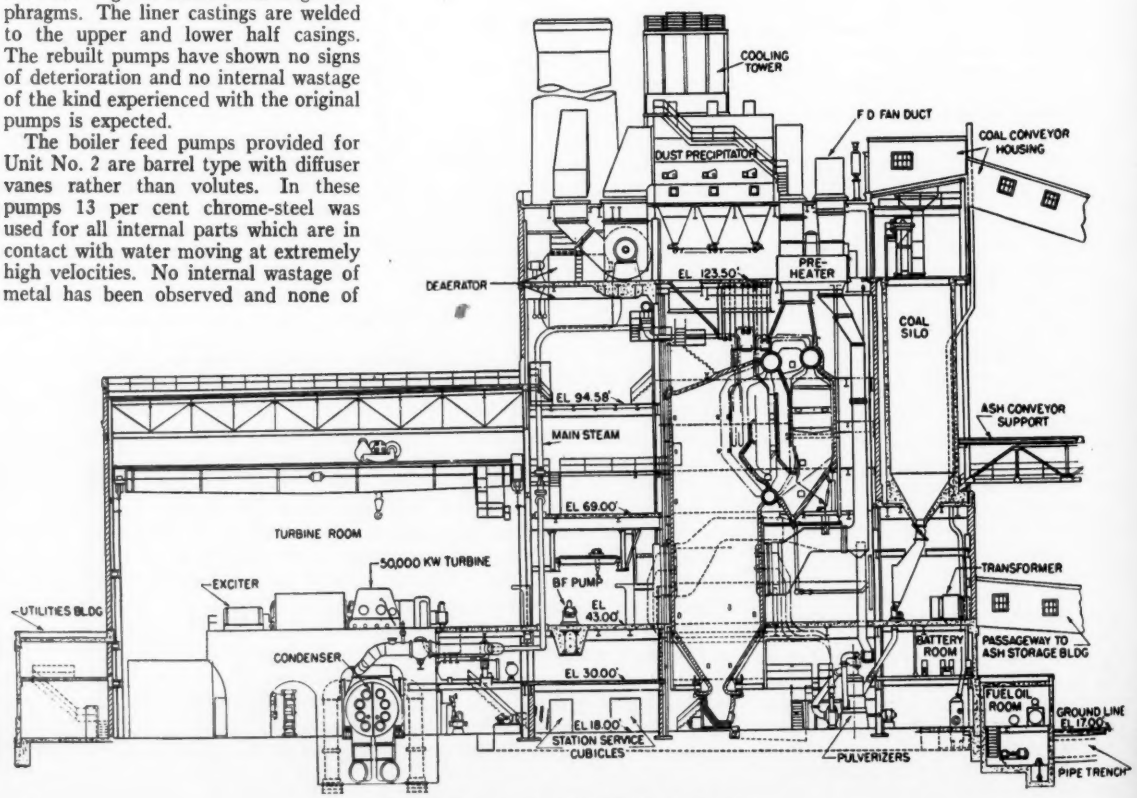


Fig. 4. Cross section through Mystic Station

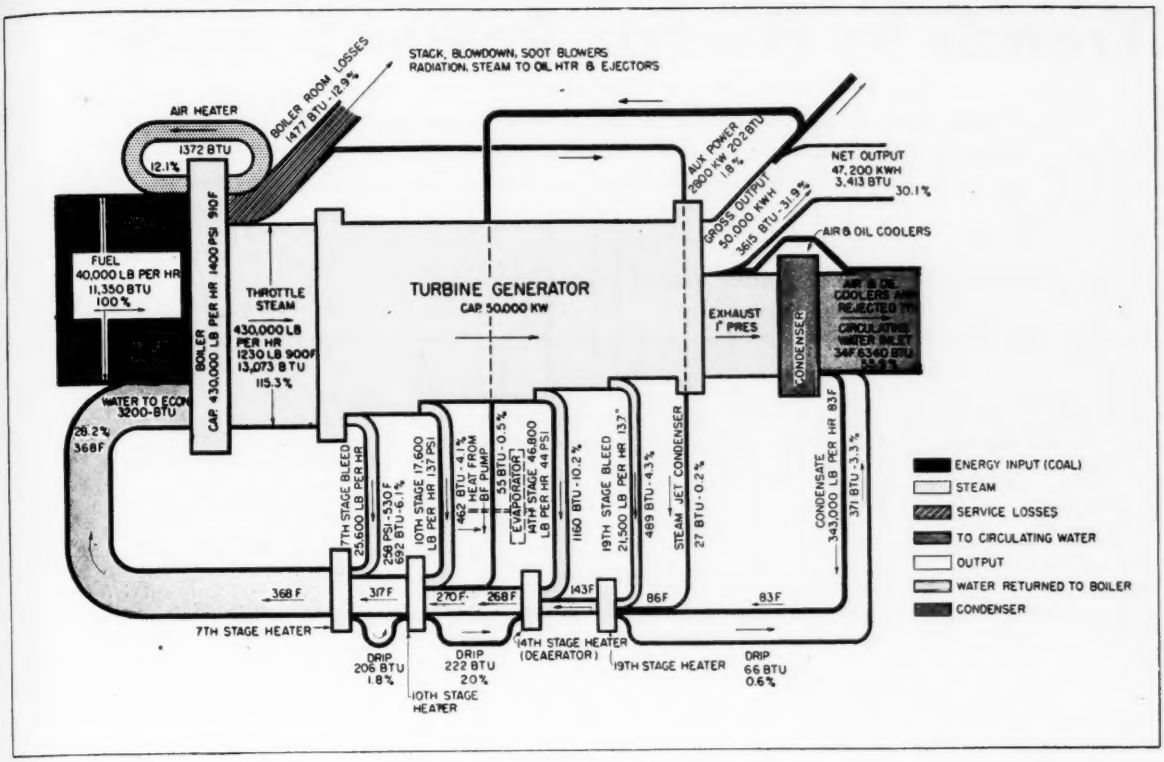


Fig. 5. Heat balance of the third unit at Mystic

riser pieces on the other downcomers. No subsequent failures from this cause have occurred in either boiler.

After six months of operation a superheater tube of Boiler No. 1 failed. Deposits in the tube indicated the carryover of solids from the boiler drum. Inspection of the steam washers disclosed the presence of a leak which by-passed the washers. This was sealed and no subsequent failure of a superheater tube has occurred.

After thirteen months operation of Boiler No. 1 a series of furnace wall tube failures occurred in which eleven tubes failed in a period of eight days. The failures were not bursts but were small leaks which indicated corrosion pits and they occurred at different points around the furnace at nearly the same elevation indicating the possibility of corrosion in all the furnace tubes above the burners and below the mud drum. Examination of the failed tubes showed extensive corrosion pitting, in which each pit was filled with an adherent mass of firm black material which proved to be mainly iron oxide. The pits varied in size up to one which was a foot long and two and a half inches wide. However, no others approached this one but ranged up to three to four inches in length. Turbining of each water wall tube individually proved the presence of the black oxide scale in all tubes, the weighed amounts varying from a half pound to two pounds with no distribution pattern discernible. New sections of water wall tubing had been welded in to replace sections removed from the failed tubes. After turbining out the material that could be removed the boiler and water wall tubes were acid washed and the unit was returned to service with a modified feedwater treatment by which free causticity in the boiler water was eliminated. Subsequently the boiler was operated for over a year without a tube failure. During this period sections of original wall tubes and sections of replacement tubes were on occasion removed for inspection, which gave no indication that corrosion was proceeding in the original tubes or that it had started in the new tubes.

Since it was highly probable that many if not all of the furnace tubes were pitted in varying degrees of severity, arrangements were made to replace a twenty-foot section of all the tubes in the furnace. However, as the work of replacement proceeded it appeared unnecessary to replace sections in all of the tubes and only 105 tubes out of 312 were repaired. In the year since the general repair of furnace tubes no failures have occurred.

A more technical discussion of the corrosion problem will be found in a paper entitled "Wall Tube Corrosion in Steam-Generating Equipment Operating Around 1300 Psi" presented by Prof. F. G. Straub at the Annual Meeting of ASME December 1946.

The station is supplied with collier shipped coal from a neighboring fuel plant about a mile distant, the coal being delivered normally in captive cars owned by the fuel company. A single track recently augmented with a spur provides standing room for the full cars and a single track hopper permits unloading the cars to the station coal conveying system, the cars being placed over the track hopper by means of a capstan type car spotter. The unloading of 11 or 12 seventy ton cars, the usual two unit station requirement, can readily be accomplished by manual labor with a single shift crew. To alleviate the difficulties with wet and frozen coal and considering also the added unloading requirements to be imposed by Unit No. 3, a car shakeout device has been installed at the track hopper and a group of oil-fired car thawing pits have been constructed between the tracks and near the track hopper. The shakeout device is a vibrator weighing four tons and is driven by a 20 hp motor. It is hung from a steel framework built into the middle section of the house over the track hopper and is lowered onto and raised from the cars by an electric hoist.

Experience with the shakeout device has proven it to be effective with dry and wet coal and it has been very helpful with coal, frozen in the cars to a depth of 3 or 4 in. With dry or wet coal, a 70 ton car could be completely unloaded without the need of any hand work in three minutes or less if the track hopper were large enough to hold a full carload of 70 tons. The hopper has a capacity of fifty tons, level full, and the minimum unloading time of a car is determined by the handling rate

(*Continued on page 124*)

Trends In Electric Power Supply

Demand for electric power grows steadily . . . Total generating capacity 50,300,000 kw . . . Fuel consumption . . . Trends in transmission line construction . . . Distribution . . . Approaching customer saturation . . . Cost trend . . . Types of management

By H. S. BENNION, Managing Director, Edison Electric Institute

THE MOST NOTABLE feature of electric power supply is the high and sustained rate of growth of demand for electric service. It continues at an astonishing rate, and the future potentialities of this service still appear to be enormous.

For several months following V-J Day during the early part of the reconversion cycle, kilowatthour sales to industrial consumers as a whole fell off. At the low point in February 1946, these sales were off 24 per cent, although the demand for residential, commercial and rural power increased throughout. Beginning in August 1945, the industrial load picked up sharply and has continued upward. The December 1946 peak load for the country rose 5,450,000 kw above the December 1945 peak load, which in turn about equalled the December 1944 peak load in the war period. Kilowatthour output in the third week of December 1946 was 4,940,000,000 kwh compared with the previous high in the third week of December 1944 of 4,617,000,000 kwh. Based on estimates from a wide cross section of electric companies, the growth of load of the utility industry in 1947 is expected to be slightly over 3,000,000 kw, and the growth of load in 1948 approximately the same. This is double our former notions of the normal rate for growth of load.

Fig. 1 shows installed capacity and peak loads through the war period and an estimate for the next two years for the public utility industry. The peak loads shown on this chart are the sum of the non-coincidental peak loads on the several systems throughout the country. They give only a rough indication of the demands on the individual system or on the interconnected power systems. Likewise the installed capacity gives only a rough picture of the capabilities of the individual systems or interconnected systems to carry the load they have experienced or will experience. But for general discussion purposes, to get the broad picture, they form a convenient and fairly satisfactory basis.

Fig. 2 shows graphically the history of power generation of the public utility industry in the United States. The dotted line at the top shows the combined production of the utility industry and of isolated industrial plants.

Several factors which contributed to this sharp growth of peak load are discernible. In the first place, industrial activity is at a high level and electric production follows industrial activity. Secondly, many factories now operate one shift per day, five days per week, and hit a high peak of activity during midweek. During the war most of them operated around the clock. This change adversely affects the load factor and helps to produce high demands. The general overall load factor which in December 1944 was 64.2 per cent had dropped in December 1946 to 58.7 per cent. In the two year period, the peak load had increased by 14 per cent while kilowatthour output had increased by only 7.5 per cent.

Thirdly, the war accelerated the electrification of industry and electrification process is definitely under way and its influence on the growth of demand for electric power will undoubtedly be noticeable for several years ahead. Starting out with an index number of 100 in 1939 both for manhours in manufacturing and for industrial use of electrical power, exclusive of aluminum and

From a paper before the Midwest Power Conference, Chicago, 1947.

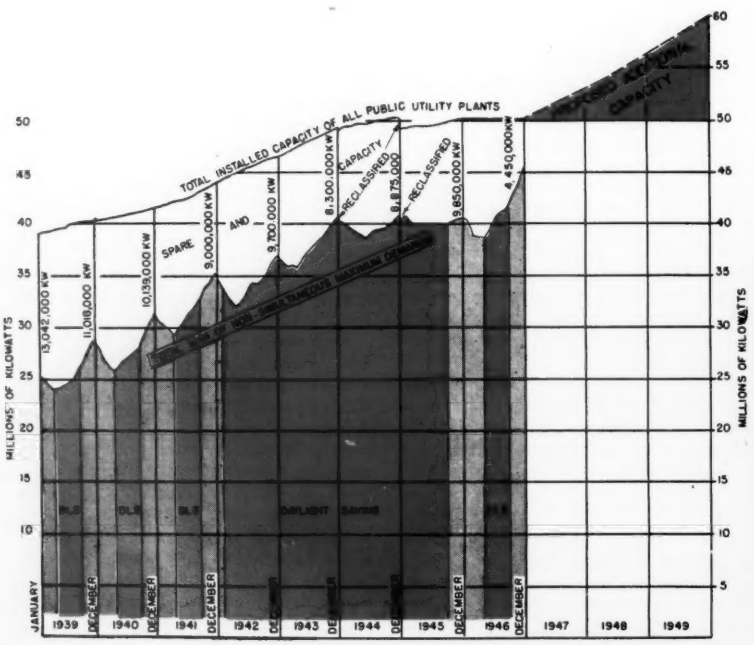
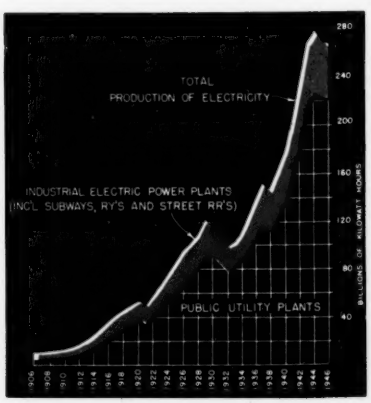


Fig. 1—Left. Installed capacity and peak loads of electric utilities

Fig. 2. History of power generation of the public utility industry in the United States



magnesium production, in December 1945 industrial consumption of electricity stood at 180 while manhours in manufacturing stood at 165.

Fourthly, electricity compared to the cost of living and particularly compared to the cost of labor is relatively much cheaper than before the war. Fifthly, there is at present a high level of aluminum production.

Generating Equipment

The total installed generating capacity contributing to the public supply was roughly 50,300,000 kw at the end of 1946. The aggregate generating capacity of this country including isolated industrial and commercial plants was about 63,200,000 kw.

Orders for new generating equipment already exceed 13,000,000 kw and it is expected that in the next five or six years 15 to 19 million kw will be installed, an unprecedented rate of installation. A review of the published reports of orders for new equipment reveals some trends worthy of mention. Out of 11,300,000 kw of generating capacity reported, about 9,000,000 are steam units, about 2,235,000 kw are hydro units, and about 65,000 kw are internal combustion units. Of the hydro about 1,700,000 kw is destined for government projects, about 460,000 kw is to be installed by business managed electric companies and the remainder by municipal and other governmental agencies.

Internal combustion engines in the central station industry in 1946 accounted for 1 per cent of the total kilowatthours produced. Most of this type of capacity now being added by the utility systems is for peak load and standby purposes.

Of 162 steam units with a combined capacity of about 7,500,000 kw to be installed by electric companies and described in press releases, 84 have a capacity of 30 to 60 thousand kw, divided as follows:

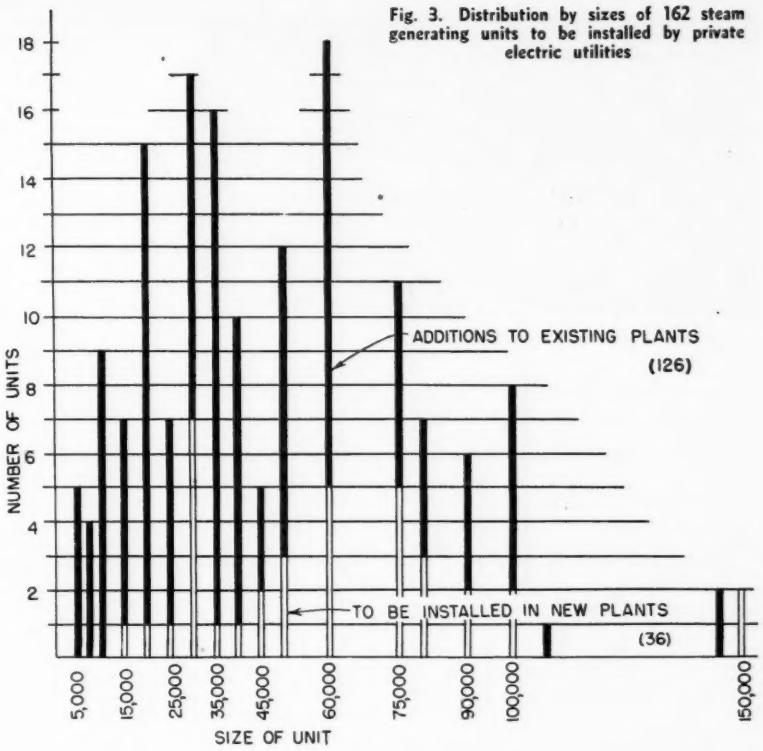
18 units are 60,000 kw
17 units are 30,000 kw
16 units are 35,000 kw
12 units are 50,000 kw
11 units are 75,000 kw
10 units are 40,000 kw

Fig. 3 shows the distribution according to size of the 162 units. The chart also shows that 126 units are going into existing stations and only 36 units are going into new plants. Undoubtedly this distribution by size and characteristics of units and their location is being influenced by the effort to speed up the date of going into operation.

Only one of the 162 units is mentioned as a topping unit. Fig. 4, shows installations over the past several years, indicates that opportunities for topping units are not now as prevalent as formerly.

The trend to higher steam pressures and temperatures was recognized in AIEE-ASME turbine standards in that provision was made in the case of the two largest sizes, namely 40,000 kw and 60,000 kw, for either 850 psi, 900 F, or 1250 psi, 950 F steam conditions.

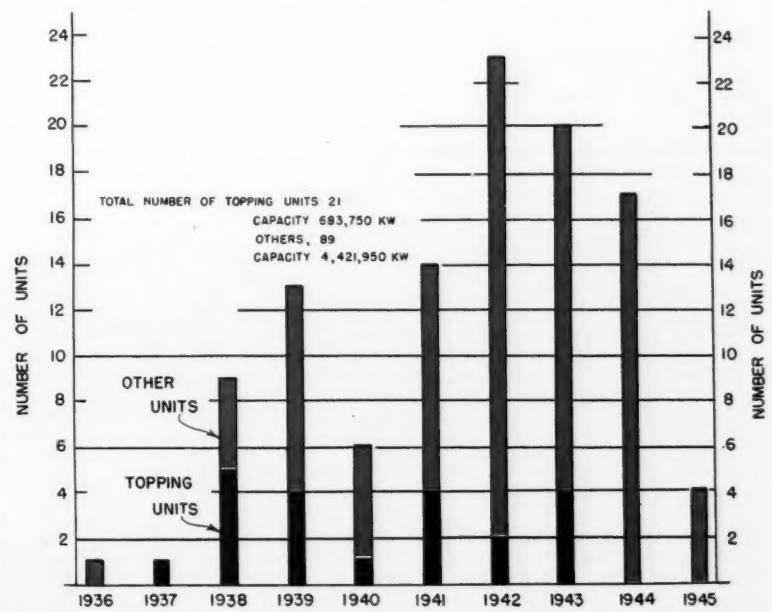
Fig. 3. Distribution by sizes of 162 steam generating units to be installed by private electric utilities



In recent years, working through AIEE and ASME, there has been some standardization of turbines and generators and there has been discussion between utility engineers and the engineers of electrical manufacturing companies on the advantages of a larger measure of standardization in all large equipment units such as turbines, generators and power transformers. This discussion apparently has borne fruit and about 25 per cent of the turbines and generators now on order follow the standards.

Another trend of station design is the low requirement for attendance labor. The latest stations require one-third or less the operating force for older stations of the same capacity. Another development worthy of mention is the construction of a number of outdoor or

Fig. 4. Installation of steam turbines, 800 psi and above, in recent years



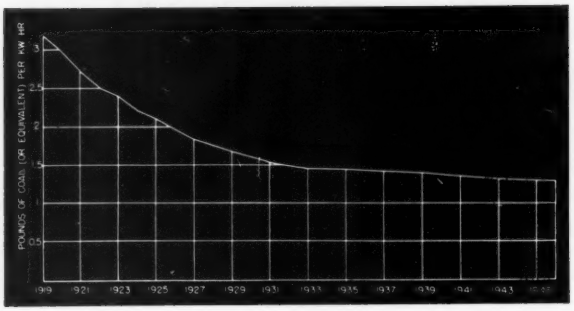


Fig. 5. Fuel used for electric generation by public utility plants 1919 to 1946.

semi-outdoor steam electric plants, not only in the southern parts of the country but in areas where more wintry weather is experienced.

Fuel

The use of oil as fuel in steam stations increased 108 per cent during 1946 above the prewar year 1939, and use of gas increased 60 per cent. Together they supplied 22½ per cent of the 1946 fuel requirements of steam stations. Before the war it appeared that the future growth in production of steam power would go to coal, but strikes and higher coal costs have altered that prospect. In this respect it shows the same influence that is manifest in the case of railroad and household fuel consumption.

During World War II power plants burned the class of coal they could get, without being too rigid as to quality requirements. Some postwar power plants in or near coal producing areas are being designed to burn a low grade coal in search for a lower fuel cost per kilowatthour. This policy will not improve the overall national figure of pounds of coal per kilowatthour generated but will favorably influence the total fuel bill and should effect better utilization of coal resources.

Fuel Efficiency

Fig. 5 shows the number of pounds of coal consumed per kilowatthour generated over a long period of years. You will notice that for several years the curve has been standing nearly still. It is expected to drop down further as soon as a considerable amount of new capacity is put into operation and as the older plants are placed on a peak load or standby basis. The average fuel efficiency of all steam stations in 1945 was about 20 per cent. The fuel efficiency of the better stations today is about 30 per cent and I am told that the fuel efficiency of a plant being built by the American Gas and Electric Co. is expected to be better than 33 per cent, far above the average performance of steam stations at the present time. In America average performance in time catches up with what was best performance.

Trends in Transmission Line Construction

In 1942 the aggregate length of transmission lines 33,000 v and higher was 160,000 circuit miles. At the present time this figure is not far from 170,000 circuit miles. Fig. 6 shows the aggregate in circuit miles of the more significant voltage classes for the period 1927 to 1942. In examining this history it is worth noting that it is nearly 25 yrs since the first 200 kv transmission line was built in California. Since that time installed capacity in generating plants has more than trebled and power output is five times the former amount. Only in the case of Boulder Dam has a voltage higher than 220 kv been built, and 220 kv lines are confined to a relatively few areas. Altogether only about 4,000 miles of 220 kv and higher have been built in this important span of years. This is a relatively small percentage of the total mileage of transmission lines. The matter of cost is undoubtedly the basic reason for the lack of trend toward very high transmission voltages. The cost of transmission lines and particularly the cost of the terminal equipment goes up very much faster than the increase in voltage. There has been much discussion and investigation during all these years of the commercial use of still higher transmission voltages. Within the past year the American Gas and Electric Co. in conjunction with the Westinghouse Electric Corp. has built and is testing out a section of transmission line at 500,000 v. In Germany before and during the war there were investigations of transmission lines at 400 kv, a-c, and 400 kv, d-c, and at 800 kv, d-c. Those investigations indicated that a 400 kv a-c line should be cheaper than the two types of d-c lines studied. The development, however, of terminal equipment for such transmission was not accomplished and American engineers investigating these German studies have learned little new concerning higher voltage transmission. Without doubt engineering and manufacturing skill in this country will some day bring about the building of transmission lines well above existing voltage levels, but our engineers know enough already about such lines to know that they will be costly and that they can only be justified where there will be huge blocks of power to transmit to a large load center at a considerable distance and where there is a substantial differential in generating costs between the sending and receiving stations. One factor influencing transmission line construction, where a large metropolitan load center is concerned is the extremely high cost and the difficulty of procurement of rights of way not only in urban areas but in the wide and expanding suburban areas that surround every large city. The increasing need for transmitting large amounts of power in urban areas has led to the use of high pressure oil pipe or gas filled pipe cable. These systems seem to offer promise of savings over the conventional type of cable and duct systems.

In the past decade there has been constructed a considerable amount of wood pole H-frame transmission lines for long cross-country mileage. This type of construction is used up to 154 kv or thereabouts although the Army in northern New York built such a line for 220-kv. The considerations that extended the use of these wood pole H-frame transmission lines are favorable performance under lightning conditions, relative costs and, since the beginning of the war, the shortage of steel for tower construction.

Distribution

In the field of distribution a few trends may be noted, the most important of which has been the rise in the average use of electricity per cus-

Fig. 6. Circuit miles of line of the principal transmission voltages

Volts	1927	1932	1937	1942
287,500	0	0	532	647
220,000	1,356	2,172	2,058	3,044
165,000	478	498	510	1,016
154,000	86	183	241	1,401
140,000	650	873	910	1,122
132,000	3,633	8,715	9,631	10,127
110,000	11,093	16,338	18,688	20,595
88,000	710	988	899	1,014
66,000	19,625	28,926	31,413	34,595
60,000	9,179	8,787	5,456	3,271
44,000	10,157	14,891	16,345	18,186
33,000	31,560	42,101	47,799	51,431
Total for all voltages 33kv and over	100,592	138,499	144,419	159,876

Fig. 7. Residential (Household) electricity

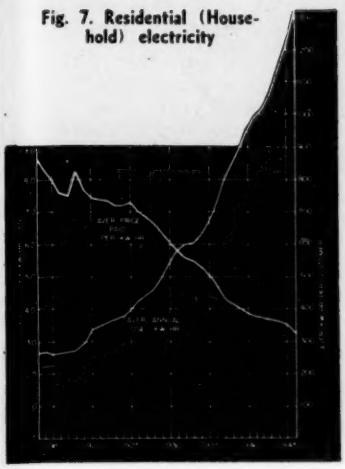
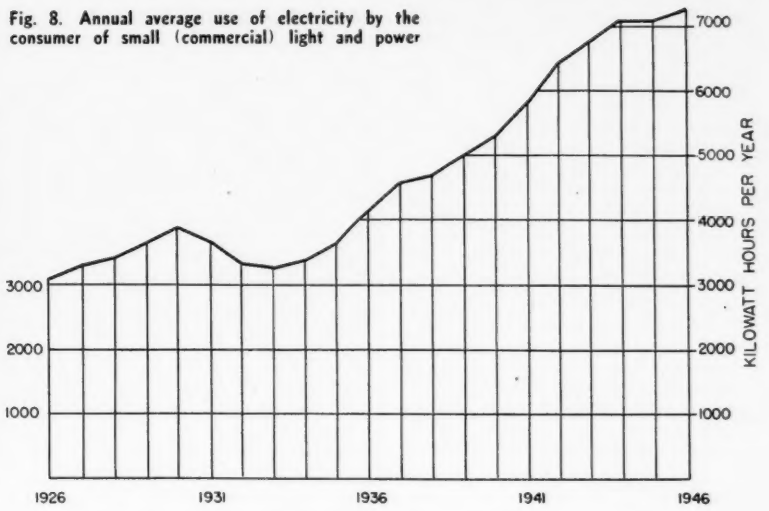


Fig. 8. Annual average use of electricity by the consumer of small (commercial) light and power



tomer. This is anticipated to continue for some years at an accelerated ratio. A couple of years ago at the beginning of 1945, a committee of commercial executives of electric companies estimated that by 1950 the average residential use of electricity would be 1800 kwh annually. Fig. 7 shows the average residential use per customer over a long period of years. Fig. 8 shows the growth of use per commercial customer. Fig. 9 shows the growth of use per farm customer, excluding the areas where pumping for irrigation may be a considerable factor. This rate of growth is the more remarkable because many of the farm customers are new customers starting out with small use which would tend to dilute the general average.

The higher use of electricity by the residential and commercial customer is bringing about a trend to higher distribution voltages. Twenty-five years ago there was under way all over the country a shift from 2300 v distribution circuits to 4-wire, 4000 v distribution or thereabouts. Consideration of voltage regulation in urban and suburban areas in recent years have resulted now in a substantial mileage of changeover to the 13,200 volt class of 4-wire distribution. In some other areas there is conversion from 4800 v delta to 8000 v Y distribution. In southern communities in downtown underground construction air conditioning loads are likewise causing a shift to higher distribution voltages. In rural areas, single phase lines with multi-grounded neutral conductor are built at 7200 v. Some years ago in joint work with the Bell Telephone System, it was found practical to go to joint use at the higher voltages in urban and suburban areas. A recent experimental line in Alabama being repeated in four or five other locations has shown the feasibility and economic advantage of long span rural joint use at higher voltage.

You have read reports of carrier current telephone circuits over rural power lines. Experiments indicate that in fringe territory this will prove a practical undertaking and the power companies as well as REA rural cooperatives are

Fig. 9. Annual average use of electricity by farms east of the rocky mountains

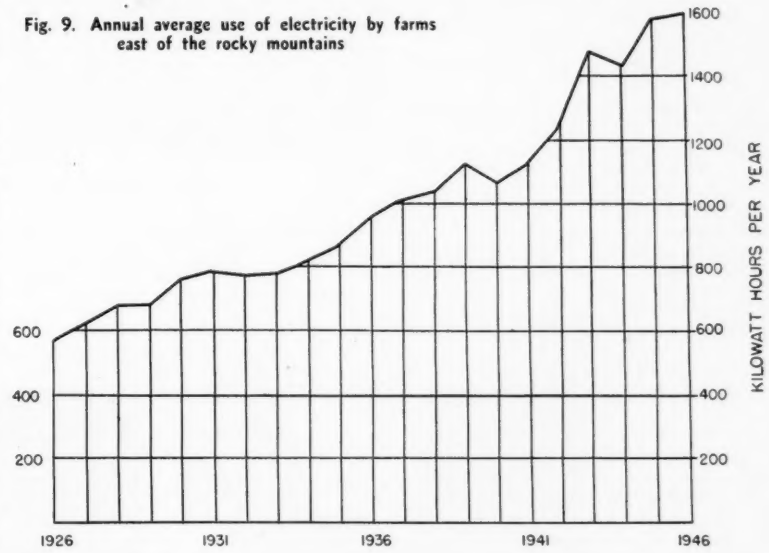
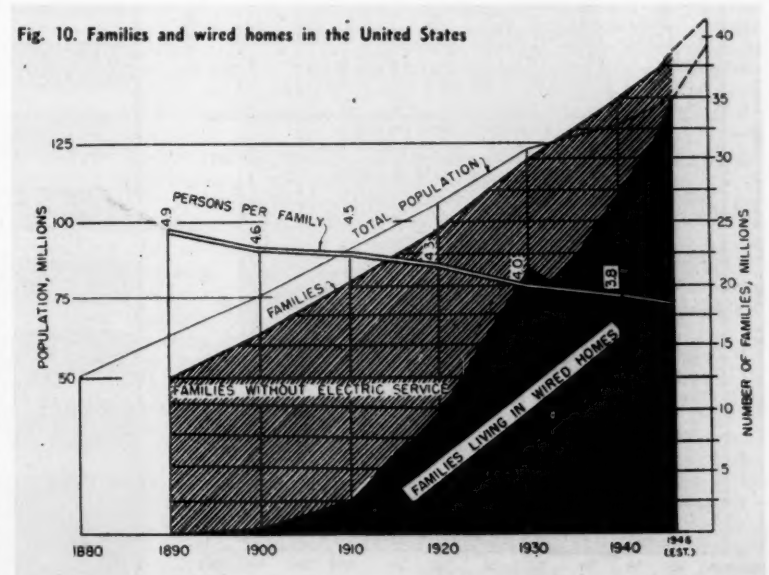


Fig. 10. Families and wired homes in the United States



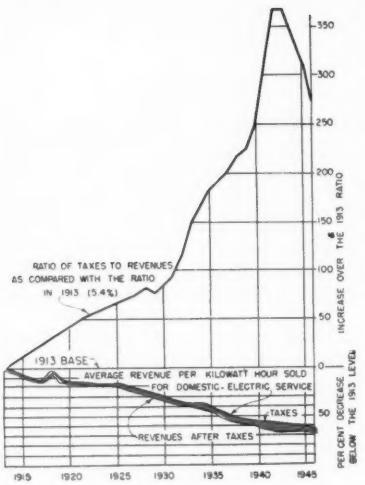

RATIO OF TAXES TO REVENUES AS COMPARED WITH THE RATIO IN 1913 (5.4%)
1913 BASE
AVERAGE REVENUE PER KILOWATT HOUR SOLD FOR DOMESTIC-ELECTRIC SERVICE
TAXES
REVENUES AFTER TAXES
INCREASE OVER THE 1913 RATIO
PER CENT DECREASE BELOW THE 1913 LEVEL
1915 1920 1925 1930 1935 1940 1945

Fig. 12. The increasing burden of taxation upon the business managed electric light and power companies as compared with the decreasing price of service

working with the telephone companies to that end.

As for underground construction, the proceedings of the engineers of utility companies and electrical manufacturing companies show a large volume of important work in that field. It used to be that a rough figure of 4 to 1 was stated as the difference in cost in the average situation of underground vs overhead construction. Thicker pavements, heavier traffic and increased restrictions on working hours have boosted this differential very substantially. As a result, underground circuits in the U.S. are generally confined to the downtown sections of the larger cities.

Approaching Customer Saturation

A report of the Census Bureau as of November 1945 showed that there were 37,600,000 occupied dwellings in the United States at that time and that 33,356,000, or 88.7 per cent had electricity. Taking into account new customers added in 1946, the Edison Electric Institute estimates that 91 per cent of an estimated 38,500,000 occupied dwellings had electricity at the end of 1946, and that electric service is available to another 3 per cent not yet taking the service. Assuming 41,000,000 occupied dwellings at the end of 1949, it is estimated that 94 per cent will have electric service and it will be available to 97 per cent of the occupied dwellings. Fig. 10 shows graphically this situation.

Substations

The trend to simplifications in substation design and construction was accelerated by the wartime shortages of equipment. Single bus instead of double bus arrangement has greatly reduced the number of circuit breakers required and has been justified by increased reliability of apparatus. The use of small substations located close together has reduced the length of feeders and promoted bus regulation instead of individual feeder regulators.

Prefabricated substations have provided flexibility in meeting load growth by adding units.

Trend of Costs

Increases in construction costs of 30 to 100 per cent above prewar prices were reported in 1946. The average was probably about 50 per cent. In considering this information, it should be observed that changes in cost bring engineering opportunities. It is the function and instinct of engineers to pull down costs and improve net results. Assuming the value of money were stabilized approximately where it now is, I venture the prediction that in ten years time engineers will have generating costs, transmission and distribution costs, whether measured on a capacity basis, a customer basis or a kilowatt-hour basis, back down near the prewar level. I call to mind that in the early Twenties, new and, for that time, higher

Fig. 11. Comparison between the rising cost of living in America and the declining cost of electricity

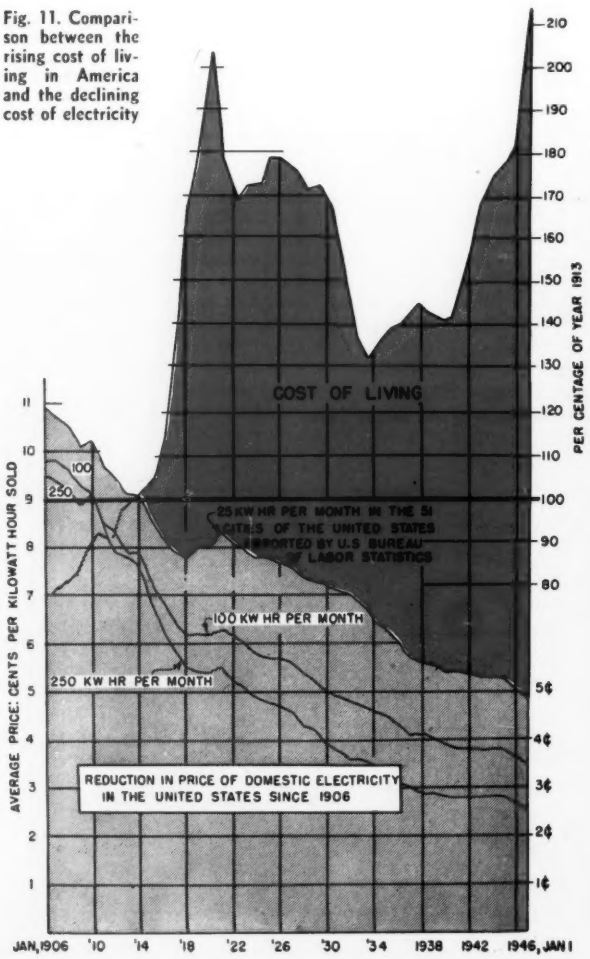
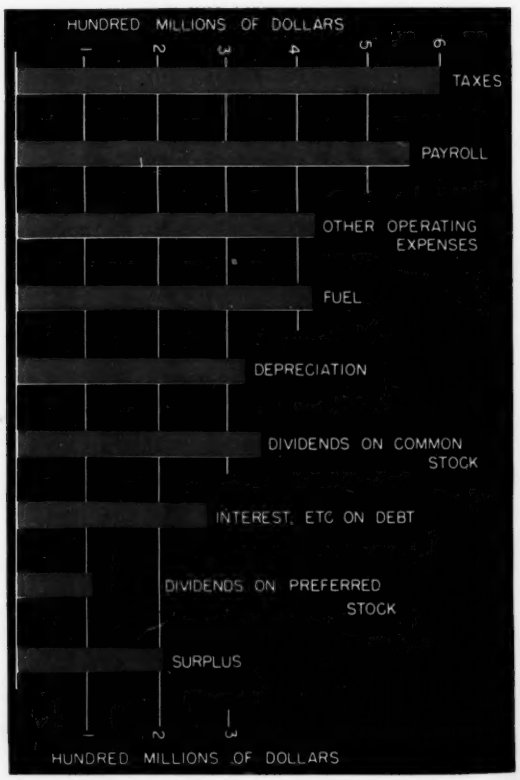

COST OF LIVING
PER CENTAGE OF YEAR 1913
AVERAGE PRICE: CENTS PER KILOWATT HOUR SOLD
100
250
25 KW HR PER MONTH IN THE SI CITIES OF THE UNITED STATES REPORTED BY U.S BUREAU OF LABOR STATISTICS
100 KW HR PER MONTH
250 KW HR PER MONTH
REDUCTION IN PRICE OF DOMESTIC ELECTRICITY IN THE UNITED STATES SINCE 1906
5¢
4¢
3¢
2¢
1¢
JAN,1906 '10 '14 '18 '22 '26 '30 '34 1938 1942 1946, JAN 1

Fig. 13. Distribution of gross revenues, electric utility companies



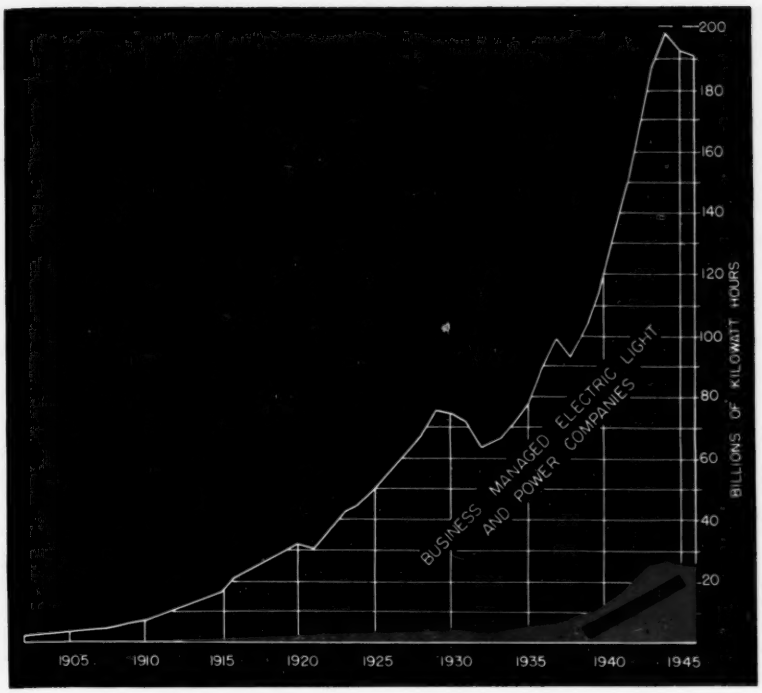


Fig. 14. Sales of electricity to the ultimate consumer

pressure steam plants were costing $145 a kilowatt, whereas immediately before World War II they were costing $70 to $80 a kilowatt. In the meantime the cost of living curve had only dropped from 170 to 145 on the 1913 basis. Although the trend of other costs is up, it is the estimate of many executives and engineers of utility companies, again assuming the value of money is stabilized approximately where it now is, that increased sales of electricity will enable the industry to continue for years to bring about the gradual reduction in the price of the kilowatthour sold.

Fig. 11 shows on the basis of 1913 the price trend of the average kilowatthour sold for residential service against the cost of living curve. Fig. 12 shows this same price compared with the trend of taxes in terms of gross receipts. These two charts show that the electric utility companies are entitled to more credit in price reductions than would appear from a consideration of the simple drop in the average price.

Fig. 13 shows for 1946 where the dollar of income of the electric utility companies went. You will observe that the two big items are labor and taxes.

Trend in Type of Management

In 1932 business managed electric companies were generating about 95 per cent of the power supply of the United States and selling about 90 per cent of the power output. In 1946 they were generating 81 per cent of the total production and were selling 85 per cent. Fig. 14 shows this change. These simple figures reveal the vitality, the sound engineering and management and progressive qualities of the business managed companies.

TECHNICAL DATA AT YOUR FINGER TIPS

(*Continued from page 67*)

vention is made by persons who write in English.

The first difficulty such a specially trained personnel would encounter would be that of terminology. What term or, in professional parlance, what subject heading, shall be used for the topic discussed in such and such an article? Mr. Hammond spoke of the loose and chaotic state of technical jargon, and that difficulty lies at the root of the problem. So important is the standardization of terminology that it might well be a major concern of the ASA or the ASTM. Not only is it vital for choice of subject headings, but a standard terminology for use in articles and reports themselves is obviously desirable.

Some central organizing group is needed to see that every worthwhile monograph, magazine, report or volume of society transactions is included in some index. Not every piece of print needs to be indexed and saved for posterity. Many house organs, society bulletins and even some magazines merely duplicate material said first and better elsewhere. There is a practical limit to the size of book catalogs and indexes. When subdivision of a subject becomes too great (too many subheads), or when there are too many entries under one subject, so much time is required to read through them that the index is impractical. Here is the value of special subject indexes such as the *Ceramic Abstracts* or *Photographic Abstracts*. The first task then would be to decide what should and what should not be indexed. An impartial board of qualified persons, expert in their own fields, could do this.

Such a group could also set up standards for form of entry to bring about consistency and the use of those methods, forms and abbreviations which use has shown to be best.

The third activity of a board for indexing current technical material could be to integrate libraries and other collections of material, so that special files, special indexes (of old information as opposed to current), special material, would be available to all. Most libraries have especially strong collections in certain subjects. The various Union Catalogs and Bibliographic Centers now scattered over the country have made some progress toward this, but they are hampered by lack of funds, personnel and co-ordination.

Terminology should certainly be one of the main concerns of this board, with terminology's corollary, the selecting of standard subject headings for every subject.

The board might also suggest apportionment of the field, if such apportionment were desirable. Thus the indexing each year of all material on aeronautics might be the task of the Institute of the Aeronautical Sciences. They might issue *"Aeronautical Abstracts"* just as the American Chemical Society now publishes the invaluable *Chemical Abstracts*.

In this brief space only the main facts of the problem can be stated and certain suggestions for its possible solution outlined. Much thought is needed before an adequate and complete answer will be evolved. The solution will require personnel trained in several techniques as well as foreign languages. Terminology must be standardized and this standardization must keep pace with new discoveries and inventions. Some co-ordinating body for general oversight must be set up. And all this means an outlay of considerable money. The effort and money, however, will be an excellent investment.

And yet, when every subject is covered by perfect indexes, there will still be need for reference librarians, those trained imaginative sleuths, who not only turn immediately to the obvious sources and indexes, but know where to look when these fail, who possess that sixth sense which is the hall-mark of the expert and that patience which is the crowning attribute of the true professional worker.

Nine Years' Operating Experience With Hydrogen Cooled Generators

By **D. S. SNELL** and **L. P. GROBEL** Turbine-Generator Engineering Division, General Electric Company

Part II. In the first part of this article the authors discussed briefly the history and general aspects of the hydrogen cooled generator. Now, in this second and last part they deal with the performance of the machines in service as well as modern developments in design

SOME OF THE principal problems encountered in the operation of hydrogen cooled generators, and the measures taken to correct them, are indicated in the following:

HYDROGEN LEAKAGE—Several cases of excessive leakage from the hydrogen system have occurred which have required much time and effort to correct. Imperfectly brazed or welded joints in the piping, imperfect valve seats, improperly fitted gaskets, and blow holes in castings, have constituted the main sources of leakage. For locating the general area of a leak, the injection of an odorant into the system has proved effective, while for tracing a leak to its source the use of an instrument for detecting the presence of inflammable gases in air, or soap water, have been used with good results. It is a good practice to provide all vent lines with sampling openings, accessible from within the station, to permit the use of a gas detecting instrument for detection of leakage through valve seats in these lines.

To determine if the loss of hydrogen may be occurring through the vacuum oil treating system, the amount of hydrogen discharged from the vacuum pump should be measured. This may be done by measuring the amount and hydrogen content of the gas being discharged from the vacuum pump. The rate of discharge from the pump may be approximated from the equation:

Cfm discharged = 0.027 × (Pump Rating Cfm) × (Abs. Pres. in Vac. Tank Ins. Mercury)

The hydrogen content of the gas discharged may be determined either by chemical analysis or by passing a sample through the gas analyzer. If the measured loss of hydrogen from the vacuum pump should be excessive, a direct leak between the hydrogen detraining and vacuum tanks is indicated. It is advisable also to check the oil flow to the hydrogen side of the seals, from rate of rise of oil level in hydrogen detraining tank with outlet valve closed, to determine approximately the loss of hydrogen by absorption in the seal oil. Normally, the discharge of hydrogen from the vacuum pump should be approximately equal to the rate of oil flow to

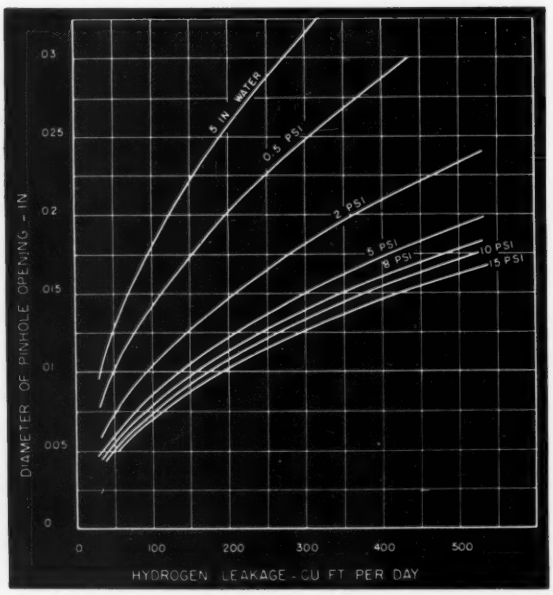


Fig. 8—above. Calculated size of pinhole opening to permit different amounts of H_2 leakage at different pressures. Hydrogen 98.6 per cent purity assumed

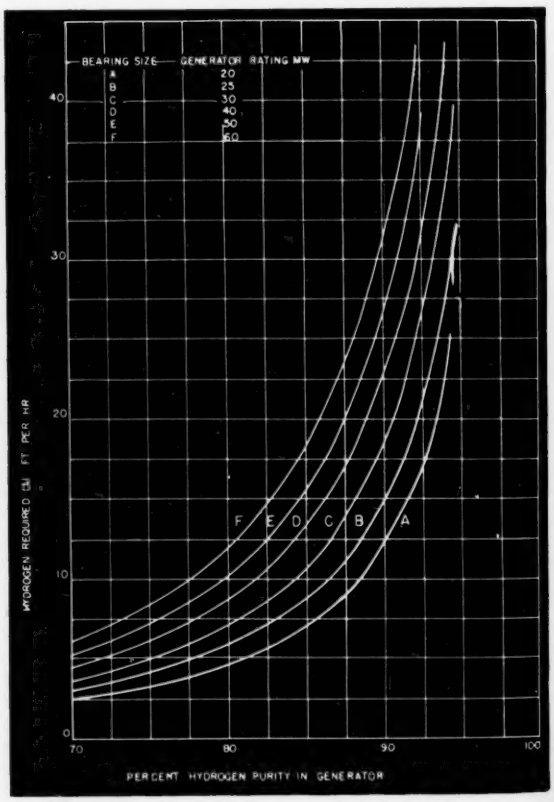


Fig. 9. Calculated amounts of hydrogen required for scavenging generators in different sizes with shaft seals supplied with untreated oil. Hydrogen 98.6 per cent purity

the hydrogen side of the seals times the solubility of hydrogen in the seal oil.

In making leakage tests it is usual to increase the hydrogen pressure in the generator to a fairly high value and, with the hydrogen supply cut off, to measure the drop in pressure over a period of time, in the meanwhile exploring for leaks in the system using the methods previously described. The loss of hydrogen (or any other gas) from the system over a given period corrected to a temperature of 25 C and a 30 in. barometer, is given by the equation:

$$\text{Loss in cubic feet} = 9.94\ V\left(\frac{P_1}{T_1} - \frac{P_2}{T_2}\right)$$

where V = gas space in system, cubic feet.

P_1 = abs. gas pressure at start of test, in. Hg.
P_2 = abs. gas pressure at end of test, in. Hg.
T_1 = abs. gas temp at start of test, (273+C)
T_2 = abs. gas temp at end of test, (273+C)

Some conception of the size of leakage opening required to cause a given loss of hydrogen at a given pressure may be obtained from Fig. 8 which shows diameter of a pin hole required to give various rates of hydrogen leakage at different pressures. It is shown, for example that an opening of 0.015 in. diameter could account for a daily loss of hydrogen of 425 cu ft, at a hydrogen pressure of 15 psi.

MAINTENANCE OF HYDROGEN PURITY —In a few cases, as the result of some mishap to the vacuum oil treating equipment, it has been necessary to operate the shaft seals with untreated oil from the bearing header for an extended period. In such operation it is necessary to manually maintain the hydrogen purity in the generator casing at a safe and economical value by periodic scavenging of the casing with fresh hydrogen. The proper value of hydrogen purity to be maintained in the generator in such operation, apart from considerations of safety, is determined by the cost of hydrogen required to maintain a given purity and the cost of the windage losses of the generator at this purity; the most economical purity being that which makes the sum of these costs a minimum.

For a given rate of oil flow to the hydrogen side of the seals, Q gallons per minute, a per unit solubility of air in the oil S, a hydrogen pressure of P atmospheres, and a purity Z_1 per cent in the generator casing, the amount of air liberated from the sealing oil to the generator, a, is approximately

$$a = 0.08\ Q\ P\ S\ Z_1 \text{ cu ft per hr.}$$

The amount of hydrogen q of purity Z_o per cent which is required continuously for scavenging out this amount of air is

$$q = \frac{a\ Z_1}{Z_o - Z_1} \text{ cu ft per hr.}$$

In Fig. 9 are shown the calculated amounts of hydrogen, q, required for maintaining different degrees of hydrogen purity in the generator by scavenging, for generators of different sizes, as calculated from the above equation using the estimated seal oil flows and a value of S = 0.10. The costs of these amounts of hydrogen in C per hour are determined by multiplying the ordinates of Fig. 9 by C_1 the cost of hydrogen in C per cu ft.

If the windage loss of a generator operating in pure hydrogen is W_o, kw, the windage loss at any hydrogen purity Z_1, is

$$W_h = W_o\,[1 + 13.36\ (1 - Z_1)\,]\ \text{kw}$$

Multiplying W_h by C_2 the incremental power cost in C/kw hour gives the cost of the generator windage loss in C per hour. For most economical operation, then, the sum $C_1q + C_2W_h$ must be a minimum. This is obtained for the purity

$$Z_{min} = Z.\ \left(1 - \sqrt{\frac{B}{A+B}}\right)$$

Where $A = 13.36\ W_o\ C_2$
$B = 0.08\ Q\ P\ S\ C_1$

In Fig. 10 the sum of the costs of hydrogen and windage loss have been calculated from the above equations for a 40,000 kw, 3600 rpm generator, for different values of hydrogen purity, and for different assumed unit hydrogen costs and the incremental power costs. A windage loss in pure hydrogen equal to 38 kw, an oil flow to hydrogen side of seals of 3.3 gpm, and a hydrogen pressure P = 1.03 have been assumed. In Fig. 11 the hydrogen purity for most economical operation of this generator is shown. It is shown that for a low unit hydrogen cost and a high power cost, the most economical value of hydrogen purity to be maintained by scavenging is between 80 and 90 per cent, while for a high unit cost of hydrogen and a low power cost, the most economical value of hydrogen purity is from 70 to 80 per cent. Since, however, safety of operation requires that the hydrogen purity in the generator be always maintained above the upper explosive limit of 70 to 75 per cent, it will usually be found advisable when operating the shaft seals with oil from the bearing header, to maintain the hydrogen purity in the generator between about 80 and 85 per cent.

MOISTURE IN TURBINE OIL—Moisture in the turbine oil in even small amounts can seriously impair the operation of the vacuum oil treating system of the generator through causing the vacuum pump to become overloaded; also through causing foaming of the oil in the vacuum tank which may lead to loss of control of the oil level. In Fig. 12 the effect of moisture in the turbine oil on the operation of the vacuum oil treating system of a 40,000 kw, 3600 rpm hydrogen cooled generator operating at ½ lb hydrogen pressure has been calculated. For this generator a vacuum pump of 26 cfm nominal capacity was provided, and the oil flows to the hydrogen and air sides of the shaft seals were estimated at 3.3 and 4.7 gpm, respectively. Multiplying these values of oil flow by the solubilities of hydrogen and air in oil given in Fig. 4 (assume oil at 60 C) and taking the sum gives the amount of dry gas to be handled by the vacuum pump at atmospheric pressure. Increasing this amount by 20 per cent to allow for leakage and multiplying by 30 (abs. pressure) gives the bottom curve in Fig. 12. The curves for different per cent moisture contents of the oil were calculated by adding to the ordinates of the curve for dry gas the amounts of water vapor contained in the oil passing to the air detraining tank of seal system, at different vacuums. The upper curve in Fig. 12 gives the final hydrogen purity in generator corresponding to different absolute pressures in vacuum tank.

The curves in Fig. 12 show that for the generator considered, the maximum

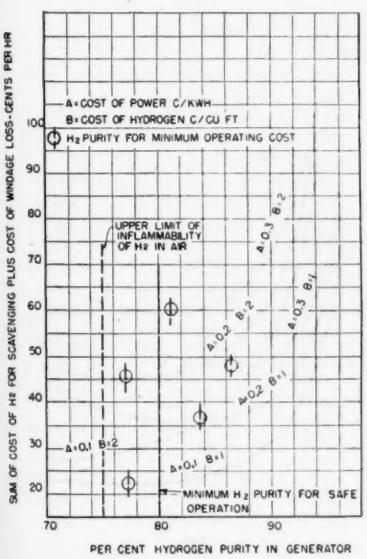

A=COST OF POWER C/KWH
B=COST OF HYDROGEN C/CU FT
H₂ PURITY FOR MINIMUM OPERATING COST
UPPER LIMIT OF INFLAMMABILITY OF H₂ IN AIR
A=0.3 B=2
A=0.3 B=1
A=0.2 B=2
A=0.2 B=1
A=0.1 B=2
A=0.1 B=1
MINIMUM H₂ PURITY FOR SAFE OPERATION
SUM OF COST OF H₂ FOR SCAVENGING PLUS COST OF WINDAGE LOSS-CENTS PER HR
PER CENT HYDROGEN PURITY IN GENERATOR

Fig. 10. Cost of hydrogen for scavenging plus cost of windage losses for a 40,000 kw generator operating with untreated oil supplied to shaft seals

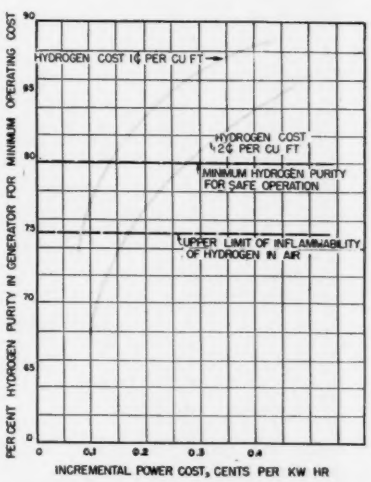

HYDROGEN COST 1¢ PER CU FT
HYDROGEN COST 2¢ PER CU FT
MINIMUM HYDROGEN PURITY FOR SAFE OPERATION
UPPER LIMIT OF INFLAMMABILITY OF HYDROGEN IN AIR
PER CENT HYDROGEN PURITY IN GENERATOR FOR MINIMUM OPERATING COST
INCREMENTAL POWER COST, CENTS PER KW HR

Fig. 11. Hydrogen purity giving minimum cost of operation for a 40,000 kw generator operating with untreated oil supplied to shaft seals. Purity being maintained by scavenging

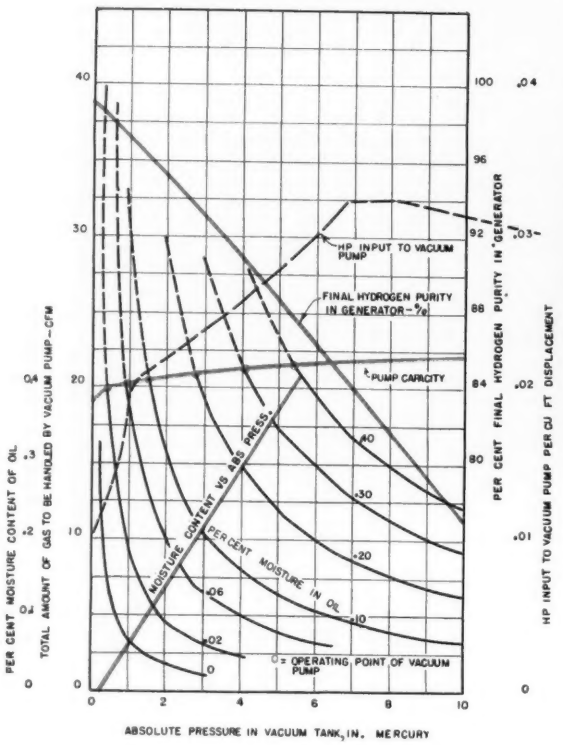

HP INPUT TO VACUUM PUMP
FINAL HYDROGEN PURITY IN GENERATOR-%
PUMP CAPACITY
MOISTURE CONTENT VS ABS PRESS.
PER CENT MOISTURE IN OIL
.40
.30
.20
.06
.02
.10
0 = OPERATING POINT OF VACUUM PUMP
PER CENT MOISTURE CONTENT OF OIL
TOTAL AMOUNT OF GAS TO BE HANDLED BY VACUUM PUMP-CFM
PER CENT FINAL HYDROGEN PURITY IN GENERATOR
HP INPUT TO VACUUM PUMP PER CU FT DISPLACEMENT
ABSOLUTE PRESSURE IN VACUUM TANK, IN. MERCURY

Fig. 12—left. Calculated effect of moisture content of turbine oil on operation of vacuum oil treating system

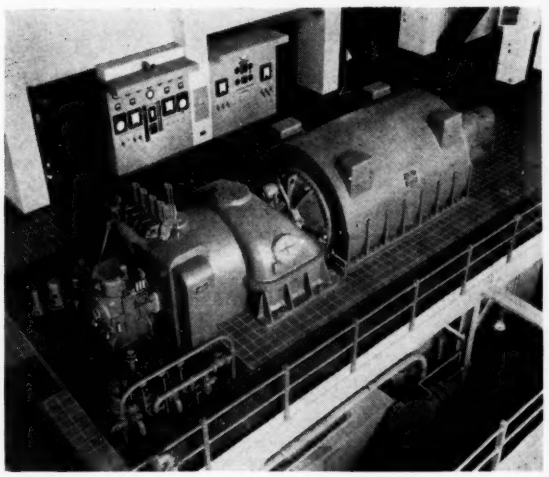


Fig. 13. Photograph of a modern hydrogen cooled generator

allowable moisture content of the turbine oil—assuming that a hydrogen purity in the generator of at least 95 per cent is to be maintained—is about 0.15 per cent. Since, however, the moisture content of the oil in most turbine oil tanks seldom exceeds 0.03 or 0.04 per cent, no difficulty is usually obtained in maintaining vacuums of 29 to 29.5 in., corresponding to hydrogen purities of 97 to 98 per cent. In the few cases encountered in which moisture in the turbine oil has been a problem, the moisture content of the oil was between 1 and 2 per cent, which, as Fig. 12 indicates, is entirely too high for satisfactory operation of the vacuum system.

Maintenance of Auxiliaries

Operation of the auxiliary equipment of the hydrogen cooled generator has been generally satisfactory, there having been no case reported in which the failure of any part of this equipment has caused the shutting down of the generator. A few items of the equipment, however, because of the nature of the service to which they are subjected, have required somewhat more attention than others. These items, and the difficulties experienced with them are as follows:

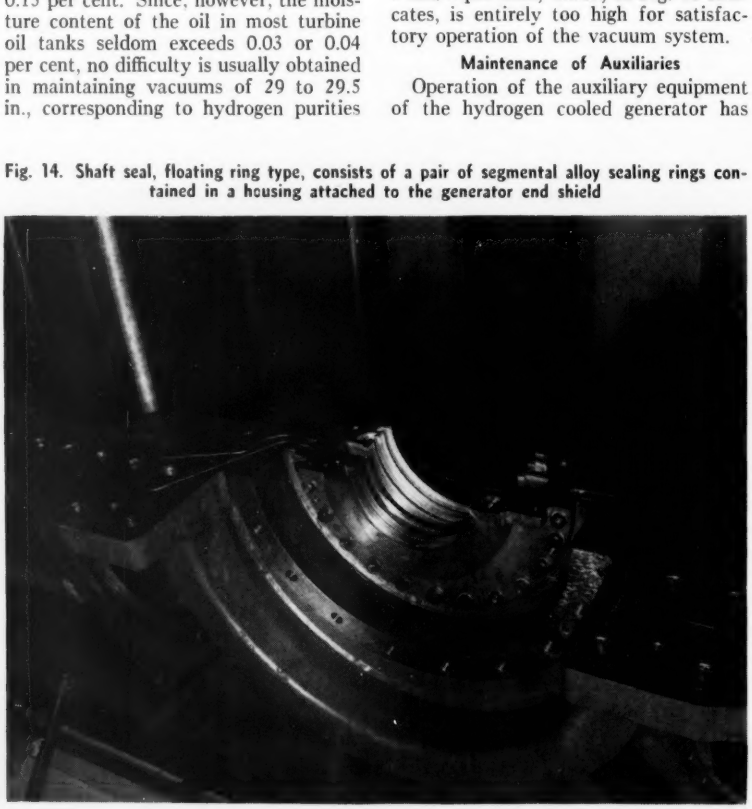
Vacuum Pump—With some of the earlier installations of hydrogen cooled generators, duplicate seal oil and vacuum pumps were provided as insurance against failure. Experience soon demonstrated, however, that with proper maintenance these pumps were entirely reliable and the practice of providing duplicate pumps was discontinued. Trouble with the vacuum pump has sometimes been experienced, however, due to excessive moisture in the turbine oil as mentioned above. This has caused overloading of the pump, as shown in Fig. 12, sludging of the oil in the separator tank, and rusting of the pump, which sometimes leads to damage necessitating replacement of parts. Trouble of this nature may be reduced by frequent changing of the oil in the separator tank during periods in which moisture in appreciable amounts may be present in the turbine oil. The rust-proofing of the interior of separator tank has been found essential to satisfactory operation.

Seal Oil Pressure Regulators—These regulators sometimes exhibit a tendency to "hunt" following pressure disturbances in the seal oil header. The provision of needle valves in the lines to the control bellows, maintained in the throttled position, appears to be the best solution of this problem.

Hydrogen Regulators—These regulators sometimes "chatter" at high rates of flow, causing damage to the valve seats. This trouble may be overcome by providing a restriction in the discharge line, such as an orifice, or a throttled valve, to increase the pressure at the outlet of the regulator.

Gas Analyzer—In a number of cases

Fig. 14. Shaft seal, floating ring type, consists of a pair of segmental alloy sealing rings contained in a housing attached to the generator end shield



the indicator of this instrument has become damaged from excessive vibration in spite of the provision of shock-mounting for the control cabinet. Supporting the indicator from the panel by means of springs has corrected trouble from vibration. In a few cases intense station illumination has caused faulty operation of the analyzer alarm (an electric-eye device). The provision of a polaroid screen for the scale, to intercept outside light, has corrected this trouble.

Recent Developments in Generator Design

GENERATOR CONSTRUCTION — Practically all G. E. hydrogen cooled turbine-generators have been equipped with four gas coolers. Originally, these were arranged lengthwise of the frame, just inside the cylindrical wrapper plate, and the majority of the machines now in service have this construction. In recent years, a different arrangement has been brought out, in which the coolers are disposed vertically at each end of the stator. See Fig. 13. This change permits considerable simplification of the flow-path of the gas and of the mechanical construction of the frame; it makes assembly or removal of coolers much easier; it brings the water piping all outside the frame and usually below it; and also permits having all the water gaskets outside the gas space. Each of the four coolers is often made in two sections, either of which may be cut out for cleaning or other servicing, while the generator carries practically full load.

The stator frames of all General Electric hydrogen cooled generators of the 3600-rpm type are spring mounted to eliminate double-frequency vibration, using the same type of spring bar mounting which has proven successful in over 50 installations. All hydrogen cooled generators are self-ventilated, using fans of either the axial flow or centrifugal types. These fans are mounted away from the rotor retaining ring so that the pressure of the fan aids in ventilating the rotor body. Exciters of both direct-connected and gear-driven types are used. Ventilation for the exciter is obtained by internal fans circulating filtered air from the station.

SHAFT SEALS—A shaft seal of the floating ring type is used with the latest General Electric hydrogen cooled generators, replacing the solid ring type of seal formerly used. This seal, illustrated in Fig. 14, consists of a pair of segmental alloy sealing rings, contained in a housing attached to the generator end shield adjacent to bearing which are held together radially and apart axially with garter springs. The sealing rings have a smaller shaft clearance than was provided with the solid ring type of seal, which results in a lower oil flow. This feature is utilized, at present, in the smaller generator sizes to obtain a sufficiently small oil flow to the hydrogen side of the seals to permit operation without vacuum treatment of the seal oil; in the larger sizes it is utilized to secure a lower total oil flow and thus

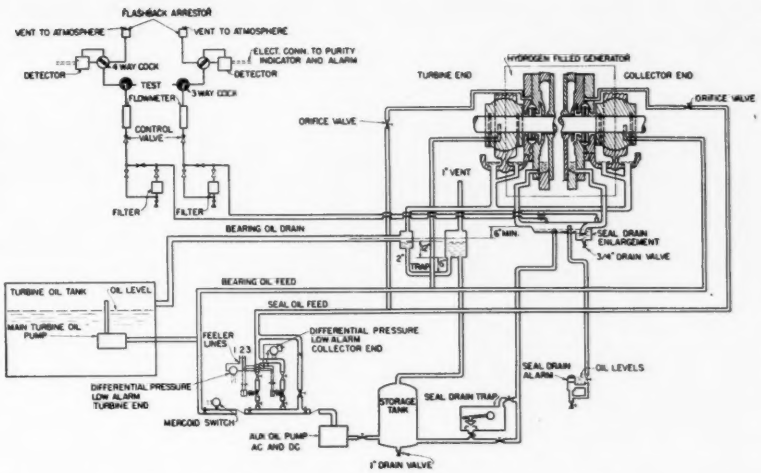


Fig. 15. Arrangement of shaft sealing system for a generator using continuous scavenging system

permits a reduction in size of the oil treating equipment.

The new type of seal also has the advantage of being mounted on the end shield rather than on the bearing, thus eliminating the possibility of hydrogen leakage through the bearing or between bearing and end shield, and permitting inspection of the bearings without the necessity of removing hydrogen from the generator casing.

CONTINUOUS SCAVENGING SYSTEM—In conjunction with the new type of shaft seal, which may be designed for a very small oil flow to the hydrogen side, a system of continuous scavenging is in use by which the hydrogen purity in the generator casing is maintained constant by permitting a small amount of hydrogen to be discharged continuously from the space between the shaft seal and the oil deflector, thus removing to atmosphere the air brought into the generator with the oil before it can contaminate the hydrogen in the main part of the generator casing. This type of scavenging permits the use of untreated oil for the shaft seals without requiring appreciably more hydrogen than is required with the present sealing system using vacuum treated oil. The hydrogen purity maintained in the space between the shaft seal and oil deflector is approximately 85 per cent for a purity in the main generator casing of 98 per cent. Referring to the equations given in Part I, the amount of hydrogen required to maintain a purity of 85 per cent, for a supply purity of 100 per cent, is $\frac{85a}{100-85} = 5.66a$, where a is the amount of air entering the casing with the oil in cubic feet per hour. For an oil flow to the hydrogen side of seal of Q = 0.3 gpm, the amount of air entering the generator with the oil, at ½ lb hydrogen pressure is approximately:

$a = 8 \times 0.3 \times 1.03 \times 0.1 \times 0.85 = 0.204$ cu ft per hr

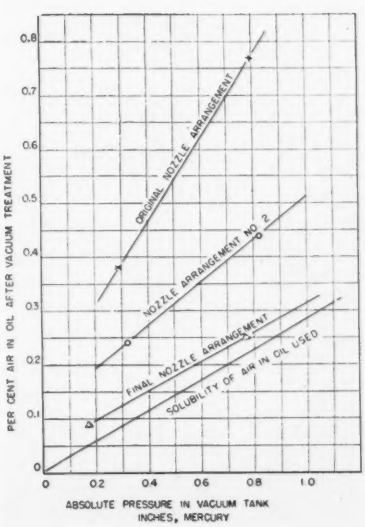
Hence the amount of hydrogen required for scavenging is:

$5.66 \times 0.204 = 1.15$ cubic feet per hour or 28 cu ft per day.

A 30,000 kw generator provided with the floating ring type of shaft seal and the system of continuous scavenging has been operating for some months with an average hydrogen consumption of 60 cu ft per day, and with a hydrogen purity in the generator casing of 98 per cent.

The shaft sealing system used with the system of continuous scavenging is illustrated in Fig. 15 and consists of an enlargement in the seal drain piping which serves to remove the larger bubbles of hydrogen from the seal oil; a trap connected with this enlargement; a small oil storage tank; an emergency oil pump to be used for supplying the seals in standby operation; two regulating valves for controlling the seal

Fig. 16. Results of tests on vacuum tank showing improvement in vacuum treatment of oil obtained by changing arrangement of spray nozzles



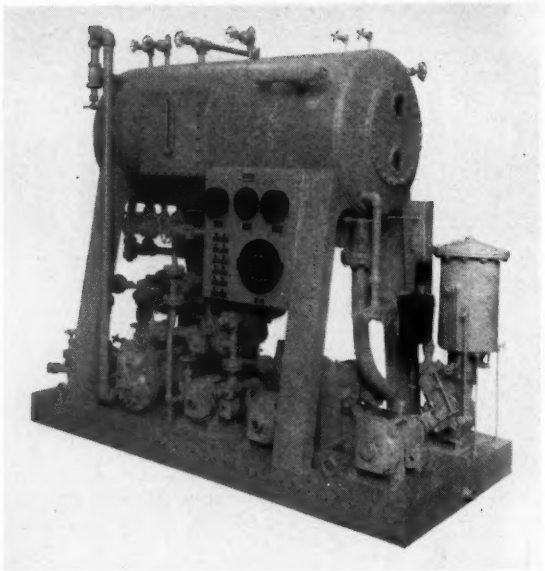


Fig. 17. Photograph showing seal oil supply unit of latest design

pressure (one serving as a "spare"); and pressure switches for operating the alarm system and for starting the emergency oil pump.

The scavenging equipment consists of a pair of flowmeters located at the control panel and connected with the seal drain enlargement, with which the rate of scavenging from the two ends of the generator is controlled. Purity indicators are provided to indicate the purity of the scavenged gas. These have alarm contacts which operate the alarm system if the purity of the scavenged gas should fall below a safe value. The control panel is otherwise similar to the panel provided with the present hydrogen cooled generators except that the vacuum gage is omitted and fewer alarms are provided.

The continuous scavenging system is at present being used only with hydrogen cooled generators in sizes below 30,000 kw. However, as further experience is gained, this system will doubtless be applied to generators in the larger sizes as well. The reduction in the amount of auxiliary equipment effected by this arrangement should make the use of hydrogen cooling attractive for generators in even smaller sizes than are now being built.

Vacuum Oil Treating System

For generators in the larger sizes, for which vacuum oil treating equipment is still being supplied, a number of changes in the design have been made to secure greater reliability, efficiency, and convenience of operation. An emergency seal oil pump has been added to the system, supplementing the emergency seal supply arrangement originally provided, through which the shaft seals are supplied from the bearing oil header on failure of the seal oil pump. The emergency pump provides increased protection in standby operation through making the hydrogen system completely independent of the operation of the turbine auxiliaries.

The efficiency of the vacuum tank has been increased through a change in the arrangement of the spray nozzles by which a greater amount of gas is removed from the oil in the first pass into the tank, leaving less gas to be removed through recirculation. The gain effected through this change is indicated in Fig. 16 in which the per cent air left in the oil discharged from the vacuum tank at different absolute pressures is shown for different nozzle arrangements. The improvement in tank efficiency thus obtained reduces the size of seal oil pump required since a lower rate of oil recirculation can be permitted.

The latest design of vacuum oil treating unit is illustrated in Fig. 17 and includes, besides the emergency seal pump mentioned above, new features which include boiler-type sight glasses, a self draining base, and an instrument panel which includes a gage for indicating the differential between seal oil and gas pressures, and an alarm system operating in parallel with that of the main hydrogen control panel.

Gas Control System

The hydrogen manifold has been redesigned to use packless valves to avoid leakage, and a more rugged type of cylinder connecting coil. The use of copper tubing for the gas piping has been discontinued in favor of welded steel pipe to secure better joints and greater mechanical strength. Thermostats have been provided in the generator casing for indicating excessive temperature of the gas discharged from either pair of coolers so that a failure of the water supply to any cooler may be at once detected.

The hydrogen control cabinet has been redesigned to include the following new features: brazed fittings and packless valves in the instrument lines (replacing compression fittings and stem-packed valves) to avoid leakage; a manometer for reading the differential fan pressure, with scale calibrated in per cent hydrogen purity at different hydrogen pressures, replacing the inclined draft gage formerly used; a flow-

(*Continued on page 116*)

Fig. 18. Photographs showing back of hydrogen control cabinet of latest design

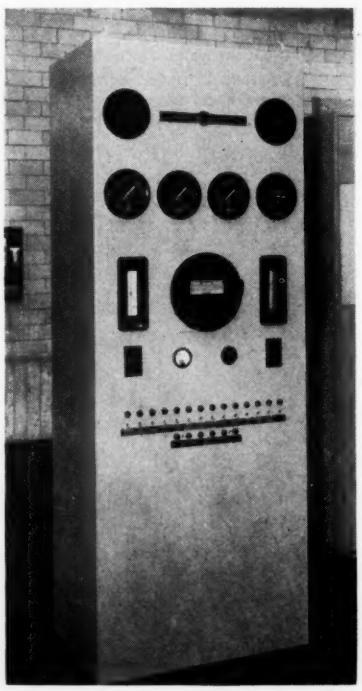
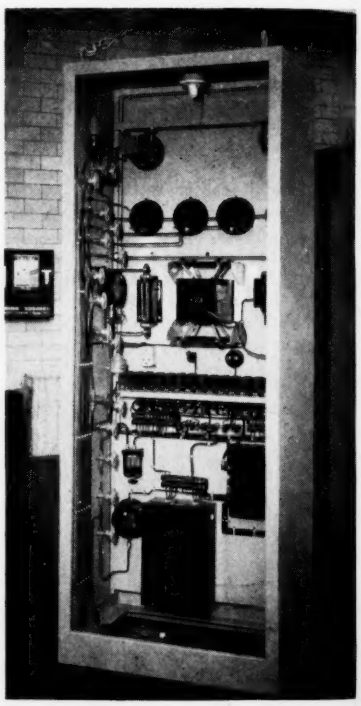


Fig. 19. This photo shows back and interior of same control cabinet shown in Fig. 18



The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

OLD TIMER, HOW LONG . . .

. . . have you been reading POWER PLANT ENGINEERING? Not, of course, that it is any of our business, but we have to fill this space up with something. Furthermore, Andy Kramer ran off to Michigan on a business trip and we can do whatever we want to with this spot.

Seriously, though, we know there are a lot of readers who have been subscribing to POWER PLANT ENGINEERING for a long, long time and we think that sort of heroism demands recognition. For example, how about you readers that have been reading it for 20 years or more? How about dropping us a letter . . . let us know when you started reading this magazine and tell us something about yourself—where you work, how long you have worked at it and any other details of interest. Send us a snapshot, too, if you have one handy.

We don't quite dare to stick our editorial neck out full length and say that maybe it might get published in the magazine. But—!

We thought, at first, we would give away a new Caterpillar tractor to the reader who sent in the most words made up out of P-O-W-E-R P-L-A-N-T E-N-G-I-N-E-E-R-I-N-G but after a quick rassle with our permutations and combinations we discovered that about ⅔ of the words in the English language with the exception of "syzygy," "zymurgy" and "onomatopeia" would fit in there perfectly. And that's too long a list.

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Rust, Industry's Arch Enemy

Seriousness of rust in the life of industrial equipment . . . Theory of rust . . . Requirements of preservative coatings . . . Use of colors to provide contrast between coats of protective coatings . . . Preparation of surfaces preliminary to applying protective coatings . . . Special treatment for galvanized iron . . . Paints for various surfaces

By THOMAS TRAIL

RUST has an insatiable appetite. Three times a day he sits down and enjoys a meal that costs nearly a million dollars. And he dines 365 days a year. The cost of his meals total a billion dollars a year—and industry pays his check!

This is a stupendous penalty that industry pays for its neglect to adopt adequate measure to combat this monster. The losses from rust annually total more than those caused by fire, water or wind. Some authorities place the figure as high as 2½ billion dollars.

Many industries have adopted elaborate fire protection measures in an effort to minimize fire losses, but not nearly as much attention has been paid to preventing the needless waste that rust insidiously causes. Rust is just as much a process of combustion as is fire, the only difference lies in the fact that rust works silently, treacherously, whereas fire, being more spectacular, demands greater attention.

The most popularly accepted explanation of iron rusting consists in what is known as the electrochemical theory. This theory holds that iron, like all other elements, has a definite, inherent tendency to dissolve into solution when coming in contact with water. Iron can enter solution, however, only by displacing some other element already in solution. When iron is immersed in water, hydrogen is the element displaced. The hydrogen gathers on the surface of the iron in the form of an invisible, thin film. This film acts as an insulation between the metal and the solution and prevents further reaction. But the presence of oxygen, dissolved in most water, eliminates this protective film because the hydrogen combines with the oxygen to form water. Of course, the hydrogen can also escape from the surface of the iron as gaseous hydrogen.

Corrosion is more rapid in acid solutions than in natural waters because the reaction between the iron and the solution is faster. More hydrogen collects on the metal surface and it is therefore forced off in the form of gas bubbles.

But it is not necessary to go further into scientific theories. Rust and corrosion can occur only in the presence of water and oxygen. Without either of these, iron will not rust! Iron rusts more rapidly when in contact with water intermittently than when permanently immersed. Also, the rapidity with which iron rusts is in direct ratio to the amount of oxygen present in solution. Iron offers such little resistance to corrosion and rusting that it is almost never safe from the effects of the elements unless given some means of protection. The essential conditions must be met in order to provide an efficient protective coating for iron. First, the coating must be highly water resistant and as impermeable to moisture as possible. Second, the ingredients must be neutral or inhibitive of corrosive influences.

Requirements of Preservative Coating

A satisfactory metal preservative coating must be able to exclude moisture and oxygen and such acids as are commonly present in concentrated industrial centers. It must do this in addition to withstanding its own enemies of destruction. From a practical standpoint it has been found impossible to successfully incorporate all of these desirable properties in a single paint. Therefore, one system makes use of a series of paint films applied over the metal surface, each film designed to perform a specific duty. The protection is scientifically built up by applying three coats of paint. The first coat serves as a barrier coat to successfully intercept the direct causes of corrosion. This is applied to new or unpainted metal surfaces. Where metal has been painted previously, it is used for spot-coating corroded areas after such corrosion has been removed completely.

The second coat acts as a reserve resistance coat, to provide a safe margin of protective endurance. This is applied as the second coat on new work or the first coat on old work.

The third coat serves as a shock coat, to give the highest attainable resistance and durability against the combined forces of destruction. It provides the finishing coat on both new and old work.

These three coats each have their definite functions. The first coat excludes moisture and oxygen thus inhibiting corrosion. The second coat serves two purposes. First, it provides a secondary defense by safeguarding the functions of the first coat after the first breaks appear in the finishing coat and thus allows a reasonable time to elapse between repainting cycles. Second, it provides a suitable rust-free foundation over which to restore the

Fig. 1. One of seven paint panel "farms" maintained by du Pont for pre-testing finishes. More than 60,000 panels of metal, wood and composition coated with paints representing thousands of formulations are exposed to the sun, wind and rain in various parts of the country so that the durability of paint is a known factor before being discarded or made available to manufacturers, painters and the consumer. (Photo, courtesy, du Pont Co.)

original protective efficiency at the lowest possible cost. And the third coat provides the shock or finishing coat that possesses all the properties essential to successfully withstanding the common enemies of paint for a maximum length of time.

Use of Colors

The colors of these three coats have been chosen with the view of providing contrast between coats. There are several sets of contrasting colors provided to suit the individual choice of the user. The purpose of this color contrast is twofold. First, to provide a practical safeguard against the probability of overlooking skips. Skips that occur in applying successive coats of paint are the most dangerous and frequent causes of trouble. They usually occur because of the painter's inability to see them, and his consequent failure to eliminate them after they take place. With the color contrasts between each coat, any skips in a subsequent coat will show the contrasting color of the undercoat, thus signalling a skip. It has been determined that if a skip occurs in the finishing coat it will cause a 30 per cent loss in protective efficiency; a skip in the second or intermediate coat a 65 per cent loss; and a skip in the first coat a 95 per cent loss. From this it can be seen that the feature of this system that provides safeguard against undetected skips is very important.

The second reason for the paint coat contrasts is that of aiding in determining when the deterioration danger line has been reached due to the gradual wearing away of the protective coating. After the finishing coat has worn away sufficiently, the contrasting color of the reserve resistance or second coat will be sufficiently evident upon careful examination, to aid in establishing the approximately correct time for repainting. If grime and dirt on the surface obscure coloring it may be necessary to wash off a spot here and there in order to make a careful examination. Of course, all other factors such as time and exposures should also be taken into consideration. Under average normal conditions, after establishing an initial three coat covering, it would be advisable to apply one finishing coat every two to two and one-half years, or two coats every four to five years. The important point, of course, is not to wait for the appearance of corrosion before taking action.

Preparing the Surface

In protecting iron from corrosive influences it is very important that careful preparation of the surface be taken care of before applying the paint. All rust, loose old paint, dirt, oil and grease must be completely removed. The best procedure in removing oil and grease is to wash the surface with naptha, frequently changing both the naptha and the rags to avoid the spreading of the oil and grease and the possibility of leaving a greasy film on the surface. It is advisable first to thoroughly wash a small area, and then wipe it dry immediately with a clean rag before proceeding further.

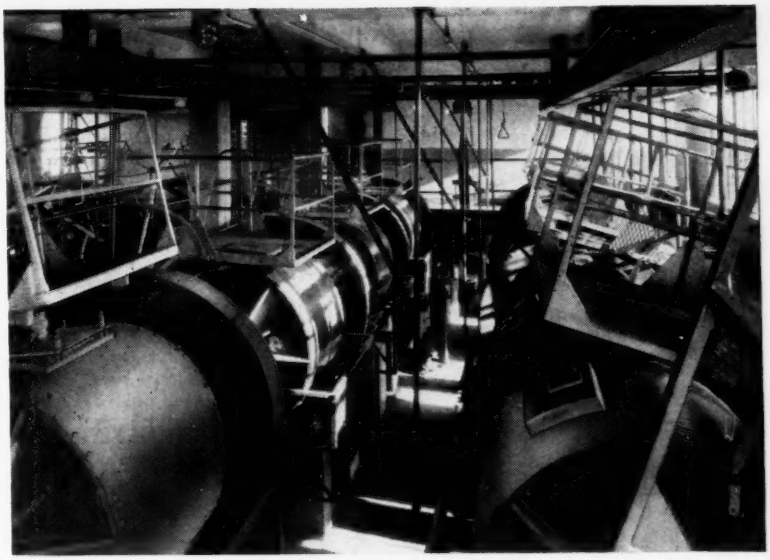


Fig. 2. Color mills in which pigments are ground into solution with the base mixture in order to obtain the various colors in finishes manufactured by E. I. du Pont de Nemours & Co. (Photo, courtesy, du Pont Co.)

Dirt and loose paint may be removed by dusting, wire brushing or scraping so as to leave a clean, smooth surface. Rust can be removed by wire brushing, scraping, or chipping, and a good job can be accomplished if the tools are efficient and are used with a determination to do a good job. But sandblasting is the most effective method, and the most economical, especially on large areas. It penetrates every rust pit to the bottom. Careful supervision should be given to insure that all surfaces are thoroughly cleaned and none overlooked.

The first coat of paint, whether it be a priming coat on new metal or a spot coat, should be applied over all exposed metal surfaces immediately after they have been cleaned and prepared for painting. This is important because as soon as metal is cleaned the process of rust formation starts all over again.

Several precautions should be observed in painting metal surfaces. Do not paint when the temperature is below 50 F. Never paint over damp or wet surfaces Before applying paint, stop large cracks, holes, etc. with good quality waterproof putty. Stir the paint thoroughly from the bottom of the container, and brush it on the surface thoroughly. Take extra precautions in cleaning and painting corners, joints and crevices to insure making them waterproof.

Where the metal surfaces to be protected are galvanized iron, special preparations are necessary. Where the galvanized iron is new, first clean the surface thoroughly with naptha using a stiff brush to remove all grease, oil and dirt. Next, treat the surface with a wash coat consisting of one pound of copper sulphate dissolved in one gallon of water. This may be applied with a brush, sponge or by spraying, or any other convenient method. If the surface turns black, it indicates that it is clean. Rinse off this wash thoroughly with clear water. Use a brush if necessary to insure removal of sludgy deposits. The surface may be rinsed immediately after applying the wash. After the surface is dry apply one coat of special primer for galvanized iron.

This primer consists of a powder and vehicle or liquid. These must be mixed in correct proportions according to directions on the container. This primer is flexible and possesses excellent adhesion properties, thus allowing it to capably withstand expansion and contraction of sheet metal. The consistency of this primer is correct for either brush or spray application. One coat should be applied, completely covering the entire area. Allow at least twenty-four hours for this to dry before applying the finishing coat desired.

Galvanized iron surfaces should be given a protective coating immediately after they are installed, while the galvanized coating is new and bright, to maintain the maximum protection afforded by the galvanizing. Where the surface to be protected has been allowed to stand until corrosion has set in, such corroded areas should be scraped or wire-brushed down to bright metal. This should be followed with the wash coat of copper sulphate solution, rinsed thoroughly and one coat of the galvanized iron primer applied.

Several special finishes are available for use under certain conditions. One of

these is the familiar aluminum paint. This paint is not recommended for priming or undercoats on iron. Aluminum paint should be of good quality, and the powder and liquid should be mixed freshly for best results. Aluminum paints for use on metal surfaces subject to high temperatures are available. They are mixed with special liquids. Where unusual conditions and temperatures prevail it is advisable to consult a representative of a reliable paint manufacturing company. He can recommend the particular aluminum liquid that will give best results.

A high-grade graphite paint may be used as a finish coat where a graphite finish is perferred. Graphite paint is not recommended for a priming coat, however.

Other finishing coats that are recommended for specific conditions of service include stack and boiler front black paint and water and acid resisting black paint. The former is intended for surfaces that are heated to temperatures not exceeding 400 F. Under normal conditions one coat produces a satisfactory finish. Ordinarily one coat will last for at least two years on surfaces protected from the weather. On smokestacks the surface should be repainted each year. This paint may be applied without a primer coat. Oil or grease and corroded spots should, of course, be carefully removed before painting. This paint requires heat for proper drying and hardening. For this reason it should not be used on surfaces that do not become hot in normal use.

The water and acid resisting black paint is particularly adapted for use on interior steel surfaces where water, acids and vapors would cause severe disintegration of ordinary materials. This paint is used without a primer coat. It is not recommended for use under any material but itself, and it is not intended for exterior work.

Where particular finish colors are desired, a wide selection is available. When used over the proper undercoats the finish job will be very satisfactory from a standpoint both of protection and appearance.

Antiquated methods that provide only haphazard protection to iron and steel surfaces are as out of date as the horse and wagon. Modern science, ever on the alert for better and more effective methods of protecting the vast properties of industry, has made notable strides in the field of protective finishes. By making use of modern products, and applying itself diligently to the protection of its properties, from the needless destruction caused by its arch-enemy, Rust, industry can save itself billions of dollars, and contribute substantially to the preservation of our precious natural resources.

In closing the author acknowledges his indebtedness to the Pittsburgh Plate Glass Co., for much of the information on which this article is based.

Memorandum On Soot Blowing

Here is a short article on a very important subject. While it is of specific interest to those working in the steel industry where blast-furnace gas is used, the factors discussed are equally important to those working with boilers fired with oil or coal fuel. The author is a supervisor in the power production division of a large steel plant and he wrote this as a memo for his own operators

By ARTHUR J. ANDERSON

THE IMPORTANT functions of soot blowing, unlike some fundamentals of modern boiler operation, cannot be standardized, but must be varied to meet the many and greatly diversified factors encountered in present day power plant boilers. To make this statement clear let us assume just two examples of contrasting conditions.

First, assume a simple 4-drum bent tube boiler using a clean fuel such as natural gas or fuel oil. Here it is obvious that soot blowing presents no great problem, and that properly installed mechanical soot blowing elements should have little or no difficulty maintaining clean heating surfaces throughout long "on the line" periods.

Second, assume a similar boiler equipped with an integral first pass convection superheater, an air-fin tube economizer and a regenerative type plate air preheater, and using blast-furnace gas as a fuel. With such construction it is logical to also assume mechanical draft of the balanced type, i.e. forced and induced draft fans.

Factors of Importance

None of the simplicity of construction of boiler number one exists in boiler number two, and there can be no reason to suppose that the elementary methods which keep the initial boiler clean will do the same for the latter. In the case of the second boiler there are several factors that must be carefully considered before a reasonable soot blowing routine can be decided upon and put into daily practice. First, the fuel, its dirt content, and it dirt deposit potential for 24 hours. Second, draft losses because of accumulations of soot upon the surfaces of the superheater elements, economizer tubes, and air preheater plates. Third, the tendency of the deposits to fuse or cake upon the heating surfaces and thereby become unremovable by the ordinary blowing process. Fourth, the efficiency of the soot blowing elements themselves. Fifth, the aptitude and skill of the operator.

These five factors are of vital importance to efficient "long run" operation and will be included in this brief discussion.

Primary, washed blast furnace gas is usually delivered at the firing point of the boilers at a temperature of from 60 F to 100 F depending upon atmospheric temperature and the distance from the blast furnaces. Its moisture content is governed to a large extent by its temperature, and also by the cleanliness and efficiency of the sealed drains on the gas mains. The incombustible dirt content varies between 1/10 gr per cu ft and 2/10 gr per cu ft. For the purpose of conservatism we will adopt the former figure and assume that a boiler burns an average of a hundred million cu ft of blast furnace gas per 24 hr. A simple calculation discloses that nearly 1500 lb of incombustible dust enters the boiler each 24 hr. These multi-millions of grains of insulating soot have a strong affinity for the heating surfaces of the boiler, and unless removed while still in a flocculent state, they will inevitably fuse and cake, and defy the best effort of the soot blower. Water introduced into the combustion area during the washing of gas mains, gas valves etc., serves to accelerate the caking of the deposited soot particles, and consequently reduces the over all efficiency of the boiler. When this action takes place in the close areas of the superheater elements, economizer tubes and preheater plates the boiler draft is seriously affected and boiler capacity greatly reduced. Every effort should be made to reduce to an absolute minimum the amount of water required to wash gas mains, valves etc. on a blast-furnace, gas-fired boiler. When soot deposits have built up and caked beyond the point where the soot blowers will remove them, slag cracking may be resorted to as a final measure. This consists of connecting a water injection to the regular soot blowing head so that when the steam is turned into the element, water at a higher pressure is also admitted, and the resultant heavy jets from the nozzles are usually capable of breaking up most of the caked soot. When this method is used there is always the danger of cracking off this semi slag in chunks that may only serve to further clog the narrow spaces around

superheater tubes and other close areas.

That brings us to the important matter of the elements, and there is plenty of reason to consider them carefully.

Soot Blowing Elements

Metallurgical science has made it possible to produce heat resisting alloys for soot blowing elements that will successfully withstand the temperatures encountered in the passes of modern boilers. Nevertheless we do have element failures, though they might better be termed "operators" failures because THAT'S where most of the blame rests when soot blowing elements fail to do their job.

Very severe temperature stresses are set up when the blowing takes place. The outer surfaces of the unit are at a high temperature and the inner surfaces are suddenly cooled as steam is admitted. Equalization of temperature causes a total change of a thousand degrees or more in the metal within a few seconds. This has hardly been realized before the cycle of blowing is over, the steam valve snaps shut, and once again the element is subjected to a thousand degree change in temperature in a matter of seconds. During this short period creep, warping, and embrittlement are almost inevitable.

What the Operator Can Do

There is much the operator can do when blowing soot to avoid or at least, reduce to an irreducible minumum, the damage to the blowing elements. The volume and velocity of the combustion gases through the passes of the boiler should be moderate. To realize this condition it may be essential to reduce the boiler load by from 25 to 50 per cent. This will first, cool the boiler and reduce the amount of the temperature change that the elements must be subjected to, thus prolonging their useful life. It will also make the blowing more effective upon the heating surfaces as the nozzle jets will be deflected less than when blowing under heavy load and draft conditions. The operator must realize that the ADMISSION point of the steam and the CUT OFF point of the steam are the critical points for the elements, and accordingly, GRADUALISM must be his watch word while operating the blowers. If the steam is yanked open and SNAPPED shut enough times, damage is sure to result. On the other hand if extreme caution is used in the OPENING and CLOSING of the steam valve there is slight danger of damage.

Periodic inspections of the elements for elongation, nozzle erosion, warping, proper arc of sweep, hanger condition, rupture and cracks must be made during boiler overhauls if proper and satisfactory results are to be expected.

On modern boilers the steam for soot blowing is delivered from the high pressure side through an orifice to the soot blowing header to aviod excessive pressure. A blowing pressure of about 150 lb gage is considered ample. A high pressure steam gage on the header where it can be seen by the operators will serve to detect any rupture, enlarged nozzles or cracks as the blowers are operated. Any imperfection will be indicated by a sub normal pressure when the valves are opened, and remedial steps can be taken.

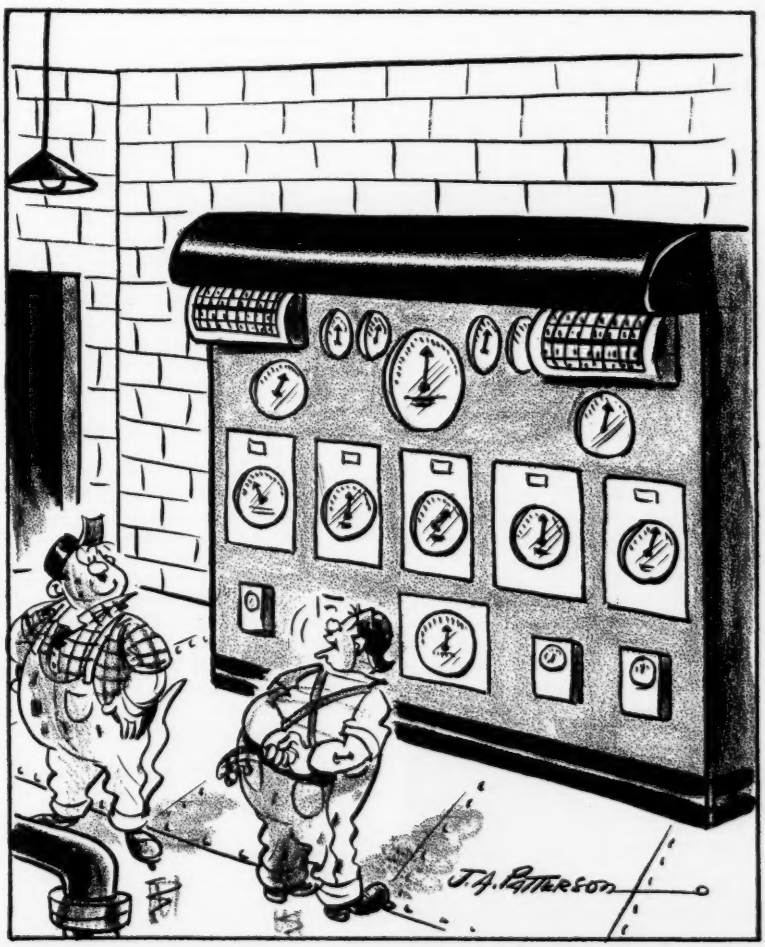
Soot Blowing vs Efficiency

Too much emphasis cannot be placed upon the importance of the soot blowing operation where blast furnace gas is the fuel, because the tendency of the dust to fuse and cake is very great. There is little doubt that the increase in boiler efficiency will more than offset the cost and trouble taken to do the job right. It is good practice to do about twice as much blowing on the front of the boiler as on the back. In other words if you have been revolving each of the blowers two turns, try blowing the hot pass and the superheater four turns, and all the others two turns as before. By following this practice, most of the blowing will take place where the temperature of the combustion gases are highest, and consequently the danger of soot adhesions and accumulations are greatest.

Modern boilers are equipped with micromax temperature recorders and draft pointer gages. Together, these instruments clearly indicate when a soot blowing operation has produced the desired results. The draft change and stack temperature drop should be studied carefully by the operator during and following the blowing operation.

It will be noted that our assumption 1/10 gr per cu ft of dust content in the gas is a very conservative appraisal, and that at times, under adverse blast furnace conditions, it could easily reach a figure of 2/10 gr per cu ft or more. Under such conditions your soot deposit potential could easily reach the three thousand pound mark for each 24-hr cycle. These facts make it crystal clear that soot blowing is indeed one of the operators MOST IMPORTANT FUNCTIONS.

In closing this discussion on the important subject of soot removal from boiler heating surfaces, it is suggested that in all cases where regenerative type, plate preheaters are in use, the preheater plates be blown FIRST, and AGAIN upon completion of all other blowing. This reduces draft friction at the plates where clearences are very small, and helps to prevent accumulation upon the plates during the boiler blowing operation.



"Elmer's gonna turn 'em all on full force . . . let's stick around and watch 'em jiggle!"

A Practical Lesson in Corliss Valve Setting

This detective story about a valve setting junket uncovers just about everything in the book . . . The author thought he had a cinch when he started to help his friend Jim correct the cards on his Corliss engine but it took many corrections and adjustments to get a passable card

By GEORGE HOLMAN

MY MOST important lesson in Corliss valve setting began one day when steam engines and valve motion were as far from my mind as the ritual of a religious cult in Tibet. My friend Jim met me on the street and asked: "How do you lower the receiver pressure of a non-releasing, cross-compound Corliss? Our receiver pressure hit 60 by the gage yesterday, and the safety valve on the steam chest of the low pressure cylinder popped. It's my job to reset the valves. Receiver pressure has always been too high. Lately it has gone higher at full load."

"There are two accepted methods of lowering receiver pressure," I told Jim, after a bit of hard thinking. "Lengthen the cutoff of the low pressure engine. This will let more steam through the ports, and give your compound more power. Or, shorten the cutoff of the high pressure engine. This will let less steam pass into the receiver, and give your compound less power."

"I need more power," Jim said.

"Then lengthen the low pressure cutoff," I advised. "Shorten the adjusting rods, increase the throw, or move the angle of the steam eccentric back toward the crank. Or, use all three methods."

"The rods are as short as I can get them," Jim said. "The throw is so far out that the rods and levers jackknife. And the eccentrics are exactly on the shaft markings."

"That's the steam gear on the l-p engine," I began to classify the problem. "Your high receiver pressure may be caused by blowby past scored rings of your high pressure piston, by blowby past scored seats of your high pressure steam and/or exhaust valves, or by blowthrough of steam from the steam chest to the receiver due to missetting of the high pressure gear or eccentrics."

"The high pressure card doesn't show anything like that," Jim answered. "The piston has new rings; and all four valves seat smoothly."

"Then your low pressure exhaust valves don't open wide enough. If the return line rises before it reaches the compression curve, the adjusting rods are too long, and the exhaust valves are throttling the exhaust."

"You might have something there," Jim admitted. "When I took out the four l-p valves and operated the engine with just the h-p side, it pulled the load much better than when in series with the l-p side. That cinches the trouble at the low side."

"It might not be there," I warned. "Did you shorten the cutoff on the high pressure engine? You do this by lengthening the adjusting rods."

"I've got her that way now," Jim said. "And the receiver pressure came down. The trouble that way is she won't pull a Model T out of the mud."

"And you're sure of your high pressure valves?"

"I don't know indicator cards very well," Jim said. "But the high side card looks alright to me. And the end marks show that the valves close just about where they ought to be."

As Jim explained it, the problem was getting more and more baffling. I turned around. "Let's go look at her," I suggested. I knew something about that engine. It was a quarter century old, had been through at least three major wrecks and had been overhauled by more mechanics than a war has generals. "Is the governor all right?" I asked, as we entered the engine room.

"It couldn't act better," Jim said. The indicator cards he had lying on the leveling plate are shown at (h-p) and (l-p) Fig. 4A.

I began my inspection by a study of these cards. Both were obviously wrong. Then I walked around to study the l-p valve gear. Both rockers came up higher on the crank end, showing that the eccentric rods were both too short. "I have to set them that way to show a balanced card," Jim explained.

Even on the head end the rockers came too high. Levers were 9 in. long center to center. The exhaust valves had adjusting rods 6 in. between threads. But the rods on the steam valves were only 4½ in. between threads. As Jim had said, the rods were at their shortest setting, except for the head end exhaust valve. "The steam eccentric has too much throw," I said. "And these adjusting rods are far too short. They almost make a straight line with the levers as the valves open."

"You're wrong," Jim said. "I'll show you." He shifted the load to an alternate engine, shut down the compound and removed the cover plates of the low pressure engine valves. While two helpers jacked the engine around, we checked valve travel. One steam valve opened only to half port, the other to two-thirds port.

I checked the tram marks, then unscrewed the adjusting rod from the head end steam valve. I set the lever as vertical as possible by eye, and went around to check the port markings. The 8-in. valve was nearly a full inch closed. "Here is your trouble," I told Jim, and tapped the stem lever. "Something's wrong here."

"The records show that the ports were rebored and new valves lapped in several years ago," Jim said. "Whether it was before or after the engine was wrecked the last time or two, I can't say. But a machinist in the shop says he did something to the valves. He either cut the ports wider, cut the slots for the T-stems, or both. He can't remember just what."

"Could the valves have been put in wrong?" I asked.

"I checked on that," Jim replied. "They're double-ported, inside admission. The numbers are right."

"The numbers could have been put on wrong."

"Maybe. Or that machinist could have cut the T-slots at the wrong angle in relation to the ports," Jim suggested.

"The stem bonnets could have been switched," I mentioned another possibility.

"The numbers check right there, too."

"I still suspect this," I tapped the head end steam valve bonnet.

We took off the bonnet. Jim loosened the clamp bolt and collar set screws. Then he spread the clamp end of the lever with a small iron wedge,

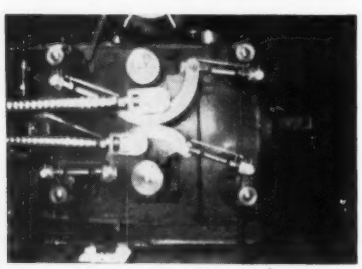


Fig. 1. This photo shows the non-releasing gear of the high pressure engine

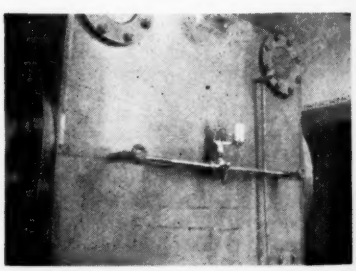


Fig. 2. Here is the indicator on the low pressure cylinder

and pulled the key. The lever came off to reveal a badly worn keyway and key. He loosened the packing gland and drove the stem out of the yoke with a lead hammer. It took no sharp eye to see that the 2 in. stem, at least the end that fit into the lever clamp, was badly twisted. The end of the keyway was at least ⅛ in. farther around the stem than the radius end that fit into the yoke bushing.

Off came the other bonnets. Two more stems were twisted, and the clamp end of a lever cracked. We had now solved the problem—we thought.

Repair proved too simple. We welded the broken lever and filled all but the inner ends of the keyways with mild steel and the blowpipe. We cut the keyways true—we thought—by setting a milling machine cutter into the inner end of the old way and cutting outward. We filed off the excess metal without troubling to turn the stems in a lathe.

The job was neatly done, and had but one drawback. The ports were still far from being wide open with levers in vertical positions. Either the T-slots in the valves were at the wrong angle relative to the ports; or, the stems were twisted beyond the ends of the keyways. We turned the stems halfway around to fit the slots, set the valves with the ports wide open, clamped the keyless levers in vertical positions and marked off new keyways. Since one or more of the stems could have been twisted past the critical point, Jim ordered new ones.

With new keyways and keys, we prepared to set the valves. We lengthened the eccentric rods until the rocker ends came up even on the upbeat, and shortened the steam eccentric throw until there was no backlash of the levers. I still didn't like the timing of the port openings, but decided to depend on the indicator for final gear adjustments.

After a 15-minute warmup, Jim started the engine. At half load and exhaust flowing into a 4 psig heating system, receiver pressure stood at 4 psig and the low pressure card we took showed the characteristics of (l-p) Fig. 4B. After some gear adjustments, we got the card shown at (l-p) C. By some further gear adjustments Jim got the card shown in (l-p) A, or almost an exact duplicate of the one he had before we started to work on the engine. "The eccentrics must be wrong," I decided, after drawing out the valves to inspect the ports and compare them with the end marks.

"See for yourself," Jim said.

We took the covers off the eccentrics. Both had heavy and old chisel marks in line with mating marks on the shaft. On removing the crankcase cover and setting the piston at the head end of the cylinder, we found that the steam eccentric as marked set approximately 170 deg ahead of the crank. After jacking the flywheel around 180 deg, we found that the exhaust eccentric trailed the crank by only 20 deg, and that there was a second mark at 35 deg.

In my puzzled mind there arose the theory that the steam eccentric of a Corliss engine should lead the crank by only 135 deg, and that the exhaust eccentric should trail the crank by 90 deg. Against this I placed the fact that no manufacturer of a steam engine would set the eccentrics wrongly and then mark them that way. Between these two ideas I set the fact that the engine had been thoroughly wrecked at least three times. A patch on the wall still showed the effects of the force with which it had once sent the l-p cylinder head through the wall into a d-c switchboard.

On another occasion the trap had been taken off the receiver for repairs. When starting up one morning steam from the high pressure side blew over the water lying in the receiver as the engine came up to speed. When the load was thrown on the engine, however, the larger quantity and higher pressure exhaust steam from the hp cylinder swept this stagnant water into the lp cylinder. The head didn't come off this time, because the crank disc burst off the shaft end.

On the third occasion exhaust steam from another engine seeped past a valve seat and accumulated as condensate in a vertical exhaust pipe. As the engine was being started, an engineer opened the valve. The water ran down and back into the l-p cylinder. The disk didn't break, but twisted about on the shaft end, shearing the key. The crank pin was loosened. Whether or not the disk had been replaced, no one knew. But our check showed that the l-p crank was approximately 100 deg behind the hp crank, instead of 90. The hp steam eccentric, controlled by the shaft governor, set exactly 135 deg ahead of the hp crank. The hp exhaust eccentric set on a heavy mark 55 deg behind the crank.

With the idea in mind that the l-p engine eccentrics had been set forward to compensate for an unknown engine fault, which if not allowed for might damage the engine, we decided to set them back a few degrees at a time until we had them at 135 steam leading and 90 exhaust lagging, or until the fault became apparent. Assuming that if 135-55 worked on the h-p side, it would make a good place to begin on the l-p side. With no gear changes, we got the card shown at (l-p) Fig. 4D.

Due to too-high compression and

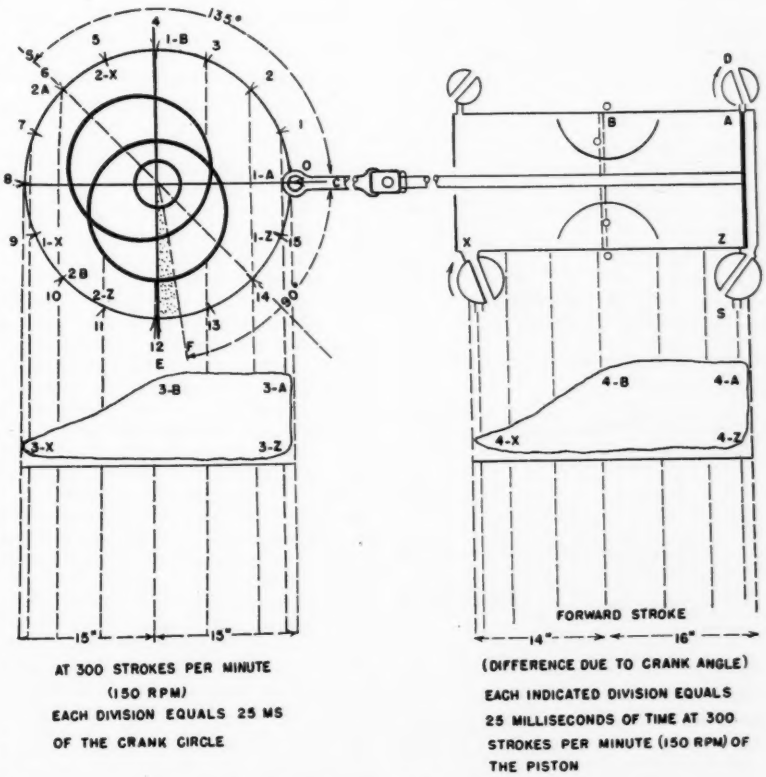


Fig. 3. The "Time Factor" in the cycle of Corliss non-releasing valve gear motion. Each crank circle division equals 22½ deg or 25 milli-seconds of time on any 150 rpm engine

Data: C—Crank at start of forward stroke. S—Steam eccentric, cutoff at ½ stroke. E—Exhaust eccentric. A-B—Steam admission period, forward stroke. X-Z—Exhaust period, return stroke. D—Steam valve open 100 milliseconds when crank moves from 1-A to 1-B, piston moves from A to B and steam eccentric moves from 2-A to 2-B. Admission movement is indicated at 3-A to 3-B and 4-A to 4-B on the cards. Y—Exhaust valve open 150 milliseconds when piston moved from X to Z of return stroke, crank moved from 1-X to 1-Z and exhaust eccentric moved from 2-X to 2-Z. Indicated movement at 3-X to 3-Z and 4-X to 4-Z on the cards. Note that release curve 3-X and 4-X is identical with compression curve at 3-Z and 4-Z only when exhaust eccentric follows crank exactly 90 deg. E-F—Cushioning angle for heavy pistons in low pressure cylinders

large negative work areas, the engine pounded heavily. We retreated by moving the steam eccentric forward. This shortened the cutoff, and again throttled engine power. When setting a steam eccentric it is well to remember that moving the angle back toward the crank makes admission and cutoff *both* later. If moved farther ahead of the crank, admission and cutoff are both earlier, and take place as at a-b-c on the card (l-p) Fig. 4A. If the throw of the eccentric is increased, however, admission becomes earlier and cutoff later. Conversely, decreasing the eccentric throw makes admission later and cutoff earlier. Lengthening the adjusting rods has an effect similar to shortening the throw, and shortening the rods has an effect similar to increasing the throw.

All along it had been apparent that compression was beginning much too early, a fact indicated by the hp card as well as by those we took on the lp engine. Negative work areas did not show on the cards because the steam eccentric opened the steam valves and permitted the compressed exhaust to be expelled back into the steam chest. But such a condition was hardly an improvement. To delay compression we moved the exhaust eccentric back to 63 deg behind the crank. But without putting the engine under load, we moved it to 75 deg lagging. We got a better card. But a deep booming sound developed, and scared the daylights out of us. I could have sworn that the piston was loose on the rod. But the card showed nothing that Jim or I could identify as a fault traceable to valve motion as the cause of the sound. We backed up the steam eccentric to 142-3 degrees, and got the card shown at (l-p) Fig. 4F. Only one more move was required to bring it to 135 deg leading for the steam eccentric, and the card shown at (l-p) Fig. 4G.

Because the l-p engine often ran with less than 5 psi differential between receiver and heating system pressure, we left the exhaust eccentric set at less than the full 90 degrees. Compression is needed only for cushioning the piston, aside from offering assurance that there will be no blowthrough and wasting of live steam from the steam chest to the exhaust. If the piston, piston-rod, crosshead and crank-rod had no weight, hence no inertia, and means were provided to make sure that the exhaust valce had closed before the steam valve opens, compression would be unnecessary.

Although the h-p card was obviously poor, we made no attempt to change the valve setting or exhaust eccentric on that side. We finally agreed that the stems were twisted by water seizure of the valves, a condition arising when too much water is carried along in the steam. But why the eccentrics were so set and marked is still a mystery.

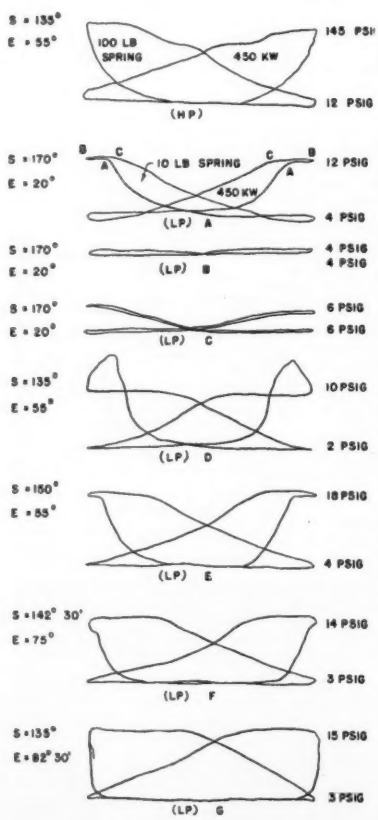


Fig. 4. Various indicator cards taken at stages in the setting of Jim's Corliss

Rebuilding a Water Settling Basin

Only available food processing water often was muddy and the present water settling basin was in a sad state of repair . . . No method of discharging collected silt was available except manual removal . . . Cutting two holes through walls of settling basin and installation of raw water tray cured turbulence in basin . . . Filling and sloping bottom of basins permitted silt drainage to sewer . . . Storage tank for fire fighting installed on slab . . . Water forced to travel diagonally to tank

By H. B. McDERMID

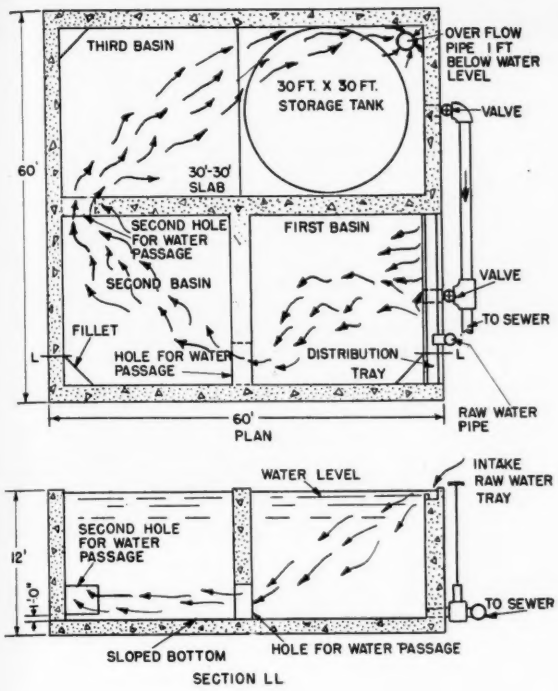
A COMPANY processing corn for its several products had use for about four million gallons of good potable water daily in its regular work.

As it was situated in a small town whose daily consumption often ran less than 2 million gallons, and was on the bank of a mile wide river, it had been decided to make an attempt to clarify this river water and use it. Some two miles above the plant location, the river had been dammed for power purposes, making a 65 mile long lake from one to three miles wide and since this made an excellent preliminary settling basin, the company had arranged to utilize it as a source of supply.

A 12 in. pipe had been laid to the plant, tapping the power plant forebay at a point ten feet below the water surface and some thirty feet above the pool bottom, thus obtaining water as near silt-free as the river conditions permitted. Under flood conditions, however, that was not at all clean, as the river then became a rich muddy brown. So at the plant location, a set of settling basins was constructed and put in operation. Due to almost unbelievably poor construction, it proved a total flop and was, perforce, abandoned. Other parts of the plant were also suffering from similar neglect so a new master mechanic was procured who promptly set out to remedy the water situation. As he was much more than busy in the other sections of the run-down plant, he hired a construction engineer to handle the work on the water settling basins.

Inspection showed the total basin size to be around 60 ft by 60 ft by 12 ft deep, but with the concrete of its walls so poorly constructed that it was impossible to carry any water above the grade of the surrounding soil on account of the heavy leakage; all that was pumped up from the 12 in. supply line leaked out in the 3 ft to 4 ft the basin walls protruded above the ground level, and meandered overland to the river, several hundred feet away, and some thirty feet below.

Unwatering the basins disclosed an unbelievable mess; the basins had been laid out with an established grade for their bottoms, and the drain opening to the sewer was 3 ft above the basin bottoms. Inquiry developed the story that the basins had been located and built first. Then the sewer excavation encountered a heavy rock ledge, close to a tall brick chimney standing on the same ledge, and serving the nearby power house. It was not deemed safe to blast the ledge to get sufficient sewer depth, and so some office man (who was not an engineer but a bookkeeper) decided to have the help clean out the three feet of slimy sludge in the bottom of the basins—some 3600 sq ft—of it by



Major changes in construction of water settling basins are noted on this drawing

hand methods every time it needed attention. The job looked hopeless but the management decided to install a heavy slab on top of piers resting on the basin bottom, on which 30 ft by 30 ft water storage tank was to be placed. The engineer got in a small rented hoisting machine, later to be used in hoisting concrete, set up a gin pole in the basin, built runways so small dump trucks could be gotten over the tops of the basins up to the hoisting rig, and started in mucking out the slimy silt. As that work progressed the concrete walls were found to be very bad. They had evidently been put in with no adequate supervision by a gang who regarded concrete as a heavy mud you had to put in forms the carpenters built when and if you felt like it. If a form was not finished—no matter—come back in a week or a month, whenever you had time, and with no regard for bonds or clean joints put in some more until the form was finally filled. The form builders had evidently made one side wall form first and after it had been filled and set, stripped the form and used the lumber for the next side at right angles to the first. No thought had been given to keys or any attempt to make a bond. And except for a fairly standard amount of cement in the concrete any resemblance to a good tight concrete basin job was purely coincidental.

It looked terrible (and it was) and there was little wonder that the operating crew had given up in disgust. Jobs were scarce, too, or the engineer would have done likewise. But as the new management seemed to be game to spend some money on the job, he decided to stay with it and see what could be done. When the basin bottoms were clean they were deemed safe to use as pier foundations for the supports for the concrete slab which, slightly above the basin tops, was to hold up the storage tank. No special obstacles were encountered in the placing of these piers or the slab, except that the work was done in mid-winter and the concrete had to be protected against freezing.

The Real Headache Begins

Then the real headache began—to attempt to seal those original basin walls against leakage. No power tools were available and all the corners and the seams left where one concrete batch had been laid on top of another, usually at the angle of repose of the wet batch, had to be chipped with hand tools and patched three or four inches deep, with rich, fine aggregate or "sand-only" concrete. At the corners, a form board was set up to form a heavy fillet across the seam between the two walls, to strengthen that joint and form a better seal. It all took a lot of hard hand labor but when it was complete all the walls were water tight. As that work progressed the engineering of the basin was examined and improvements decided on. First, the basin floors were filled with solidly tamped clay high enough so that the basins could be drained rapidly to the sewer with the finished concrete floor slanted decidedly toward the drainage openings.

Then, (see sketch) the wall at the water's entry point was partially cut away at the top and a distribution tray, with a carefully leveled lip, was made in it, so that the entering water spilled equally over it the full length of the wall, so that as little disturbance as possible was produced in the first basin. Originally, the water circulation had been planned to go over the top of the final wall in the first basin, but remembering the deep coffee brown of the flood-time raw water, it was decided to make the water travel as far as possible and also provide, at the same time, a place for washing out the silt from the second basin. So a large hole was cut through the division wall, its bottom flush with the basin floors; thus the moving water had to travel across this first basin diagonally, both vertically and horizontally, and very little turbulence was set up in its passage through the 6 ft x 12 ft opening.

Then, another large hole was cut through the wall of the second basin, set about one foot above the floor, to allow that depth of silt to lie undisturbed in the second basin while the water traveled across it on a horizontal diagonal. From this point the water traveled across the third basin, its course being again diagonal, both vertically and horizontally, until it reached the over-flow pipe which came up through the bottom of the basin to take in clean water at a point a foot below the surface.

When the plant was put in operation, it resulted in water circulation so quiet that no movement could be noted anywhere with the naked eye, and the product, aided by the rather crude method of dumping a bag of alum crystals in the raw water distribution tray, was clear as crystal visually and was good enough so that when occasionally short, the city purchased water from this basin on several occasions.

After a period of time, when the silt became too high, it was only necessary to unwater the basins by opening the sewer valves, get into the upper end of the basin with a fire hose and flush all silt to the sewer, and in two hours the plant was ready to go again, and the miserable cleaning job of former times was only a short, easy proposition with the new layout. Except for the short cleaning period, when city water could be substituted easily, the plant had a plentiful supply of its own water, clean and cheap, and always ready.

COAL VS. OTHER ENERGY SOURCES

Arno C. Fieldner, Chief, Fuels and Explosives Branch, Bureau of Mines, had this to say about fuel reserves: "All evidence points to very much larger reserves of coal than of oil and gas . . . where all the mineral fuels are expressed in equivalent tons of coal of 13,000 Btu per pound of calorific value. The total of all ranks of coal amounts to approximately 2,600 billions of tons of 13,000 Btu coal, whereas the proved petroleum reserve is equivalent in heating value to only 4.8 billion tons of coal and the proved natural gas reserve is equivalent to 5.2 billion tons. Excluding fissionable materials, coal comprises 98.8 per cent of our mineral-fuel energy reserves. Oil shale amounts to 0.8 per cent, petroleum to 0.2 per cent and natural gas to 0.2 per cent.

Servicing Elevator Ropes At Carlsbad Caverns

By **ROY L. PARR**, Elevator operating engineer for the National Park Service at Carlsbad Caverns, Carlsbad, New Mexico

Cleaning, inspection and lubrication methods and costs . . . Tension adjustment and cut-back practice outlined . . . Original hoist was a steel barrel, hung by a wire rope, and operated from a winch

IN THE OPERATION of our two passenger elevators here at the Caverns we use 9075 ft of ⅝ in. preformed wire rope. This rope is 6 by 19 scale traction steel wire elevator rope, preformed with hemp center.

One elevator operates with six ropes, each one 825 ft in length. The other elevator has five ropes of the same length — 825 ft. The shafts are 7 by 15 ft, with a depth of 754 feet.

Our problem of wear from bend is greatly minimized because our ropes are bent but once for each 754 ft of elevator travel. While with the average three story building elevator, similar ropes would bend 30 times in making an equal travel distance.

But to offset this advantage we have a constant bogie from dampness.

Proper Lubrication the Only Answer

Before each lubrication and inspection our ropes are cleaned down with a steel brush. We use a recommended fireproof cleaner. Kerosene should never be used because of the fire hazard.

We can clean the five or six ropes at the same time and it requires approximately 6 hr thoroughly to clean the ropes on one elevator. One gallon of commercial fireproof cleaner will clean the ropes on one elevator. This cleaner costs now $1.20 per gallon.

After the ropes are cleaned they are given an inspection. We also use an elevator inspection service which costs us $150 per year on both elevators and includes checking the ropes, grooves, and general elevator condition at least once each six months.

In lubrication, we have found that the lighter lubricant gives us far the better service. We use a factory recommended lubricant with a viscosity rating of 20.

The lubricant is applied with a cold bath method. Two pans, inset with bristle brushes, are buckled around the ropes, and the lubricant is fed from a tank by gravity. It requires about 3 hr to give complete lubrication to the five or 6 ropes—or a total of 6 hrs to lubricate the ropes on both elevators.

Fig. 2. The steel barrel used by Jim White, the early cowboy explorer. This barrel was operated from a winch, two passengers to the trip, one leg in and one leg out, the passengers hanging onto the rope as they were lowered into the caverns

For the complete lubrication of the more than 9000 ft of rope it requires approximately 2½ gal of lubricant at a cost of $1.80 per gallon.

Thirty-six hours time during a year and around $11 for cleaner and lubricant will keep our elevator ropes in excellent condition. This plus the inspection and service charge we feel is a very cheap insurance rate. We know that because we are using the proper ropes on our elevator and giving them proper care we are receiving big dividends in longer safe life.

No Whipping With Preformed Wire Ropes

On one or two occasions I have been told by elevator operators that preformed wire rope, for the longer than average drop, had a tendency to whip. My experience with our ropes has been exactly the opposite.

Each six months we equalize the tension by the use of a turnbuckle. This gives us the same tension on all ropes. The stretch runs around 22 in. per rope for 72 months, and the cut back for each of the 11 ropes, cut each six years, will not vary more than 2 in. from the 22 in. average.

Since the elevators have been installed we have had no evidence of wear on our drums. We believe this absence of whipping and absolute uniform drum spooling is due to the preforming which the rope is given when it is made.

Light Weight Lubricant Used

As I mentioned before, our biggest worry is the condition of dampness which exists in our shafts. While there

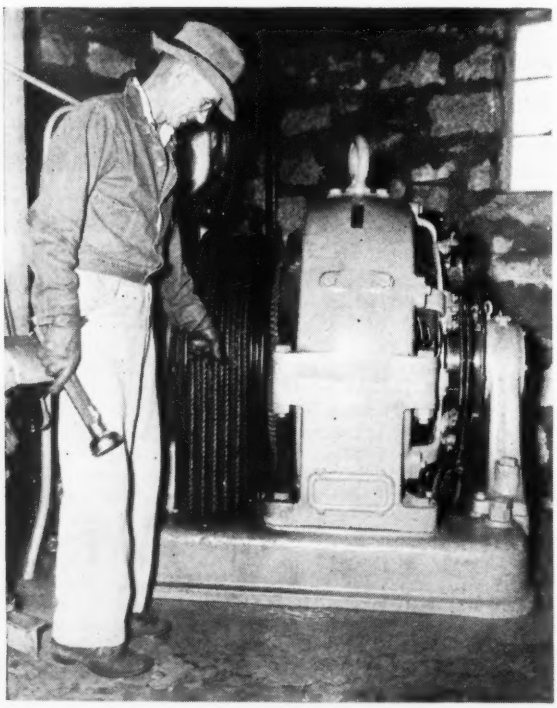


Fig. 1. Here Roy L. Parr, operating engineer at Carlsbad Caverns points to the drum grooves on the five rope elevator

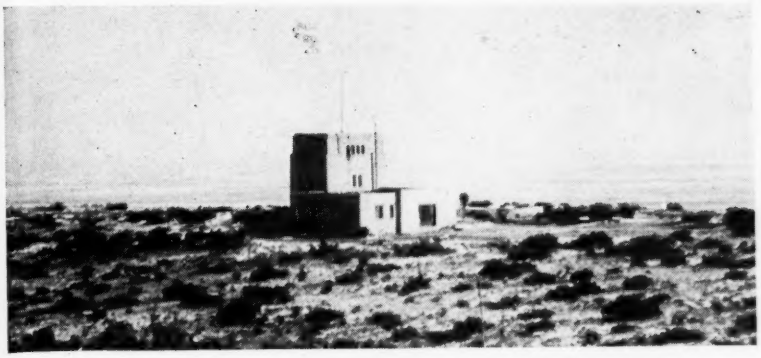


Fig. 3. The building at the top of the elevator shaft—Carlsbad Caverns.

is no direct seepage our ropes come back damp after each trip.

We have tried using heavier than 20 viscosity rating on lubricants and found that the water or dampness works into the ropes. Experimenting with a short section of rope, we found that the cold bath treatment with 20 viscosity grease gave us the best job and kept the hemp center wick well oiled.

Examination of hemp center on test sections of rope, where one section was lubricated with a heavy lubricant and the other with a light grease, readily proves the point. Even with constant bending (which our ropes do not get) there is little of the heavy grease which actually reaches the hemp core.

On the other hand, when light lubricant is used the core is well saturated and the inner wires next to the hemp core are as well lubricated as the outer wires.

Similar tests on sections of non-preformed and preformed ropes show similar results as to the advantage gained when using a grease with a viscosity of around 20. However, the hemp core on sections of preformed rope shows a more even degree of saturation than the hemp core of sections of non-preformed ropes given the same lubrication tests.

Jim White, the cowboy explorer who did untold work in promoting and opening the caverns to the public, sunk a shaft and lowered his visitors in a steel barrel. The barrel was operated from a winch. Two passengers to the trip, one leg in and one leg out, hung on to the wire rope as they were lowered into the cave.

This steel barrel now hangs at the bottom of the cave for visitors to see—visitors who have made the trip through the different rooms of the Caverns and are ready to be whisped to the surface 754 ft above in one of our high speed gearless passenger elevators.

PRACTICAL HINTS AND KINKS

WHY COLD-CHISELS BREAK

By W. B. Kennedy

I HAVE learned from experience that cold-chisels are broken perhaps more often from misuse than because of improper tempering, especially home-made chisels. When a cold-chisel is used as shown in Fig. 1 breakage may occur frequently regardless of proper temper because the stress or strain on the tool is not equally divided. (Too much stress is produced at the point indicated by the arrow because of lack of support.)

To distribute the stress as evenly as possible, use as shown in Fig. 2 when possible. Fig. 3 is possibly a better method if conditions will permit. I have practically eliminated breakage in chisels by adopting methods that distribute the stress evenly.

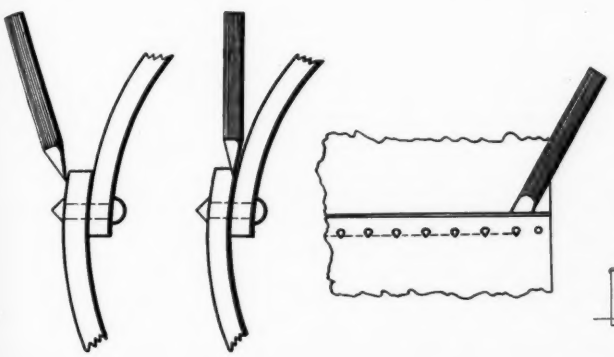


Fig. 1—Left. Too much stress near the point of the chisel and no support on the other side is liable to cause breakage. Fig. 2—center. Partial support on the outer side of the chisel is afforded when it is used in this manner. Fig. 3—right. 45-deg angle gives better cutting contact and also produces less strain at point of usual stress

HINTS FOR THE LATHE USER

By William Sheffer

HERE ARE a couple of suggestions that may be of interest to those readers of POWER PLANT ENGINEERING who are concerned with the operation of machine shops. The drawing of the spring winder is self-explanatory. As for the back gear shaft oiler, it is very convenient when it is desired to oil the shaft without stopping the lathe. This situation sometimes arises when taking long cuts on threads, heavy cuts and so forth.

STURDY HANDLE

By James Lade

A VERY substantial and comfortable door handle can readily be made in the shop from odds and ends of scrap metal. As shown in Fig. 1, a short length of pipe, threaded on both ends, is fitted with two pipe caps. The caps have been

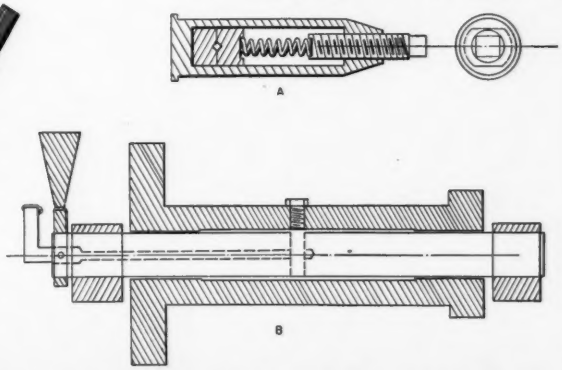


Fig. 1. A Shows the sketch for the spring winder. B is the back gear shaft oiler used to oil the shaft without stopping the lathe

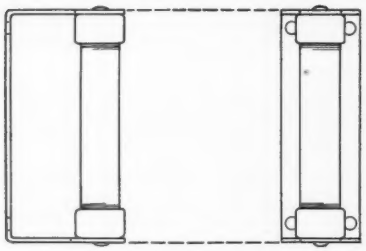
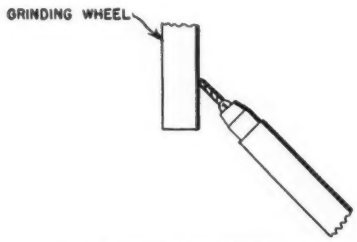


Fig. 1. This sketch explains the method of using short lengths of pipe and two pipe caps to make door handle

previously drilled. Then a short length of strap iron is drilled and bent into a U-shape, and riveted to the pipe caps by means of a rod passed through the holes in the caps.

SHARPENING SMALL DRILLS

WHEN RESHARPENING small drills on a grinding wheel, a pin vise provides a convenient means of holding them. In



Drill mounted in pin vise

this way it is easier to know just which parts of the drill point you are grinding since the drill cannot rotate unless the pin vise is rotated.

SIMPLIFIED METER READING

By Thomas Trail

IN READING meters that are equipped with registering hands, it will be found simpler to read from right to left than from left to right. By starting with the right hand or lowest reading dial, the reading of each dial will then serve to check the reading of the next dial. This eliminates the necessity sometimes, when reading a dial, of going ahead to note the reading of the next lower dial, as a check, and then back to the higher dial again.

An example is shown in the accompanying sketch. The registering hand of the left hand dial points to 4 but the reader cannot be sure that it is at 4 until he looks at the next lower dial. Since he sees this dial registering approximately 9, he knows that the hand of this dial has not completed a full revolution, therefore, the hand of the first dial has not reached the 4, so the reading is 3.

The same situation applies in reading the second dial. Since it is uncertain whether the hand has reached the 9 on this dial, it will be necessary to note the reading on the next lower dial as a check. Since the hand on this dial has completed a full revolution, it proves that the preceding dial hand has reached the 9. But it will also be necessary to check the lowest dial in order to be sure that the hand on the preceding dial has actually reached the zero.

However, when the reading is taken from right to left, the procedure is much simpler. Then the first dial indication can be noted as 1. It is easy to remember that this hand has completed a revolution. Then you will automatically know that the next higher dial hand has passed its number. Since this hand has completed a revolution, the hand of the next higher dial will have passed its number, and so on.

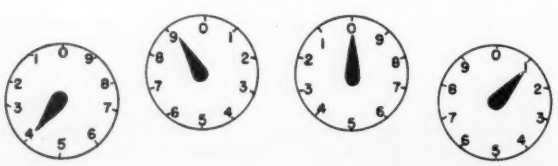


Fig. 1. The author shows why meter reading is faster and more accurate when done from right to left than vice versa

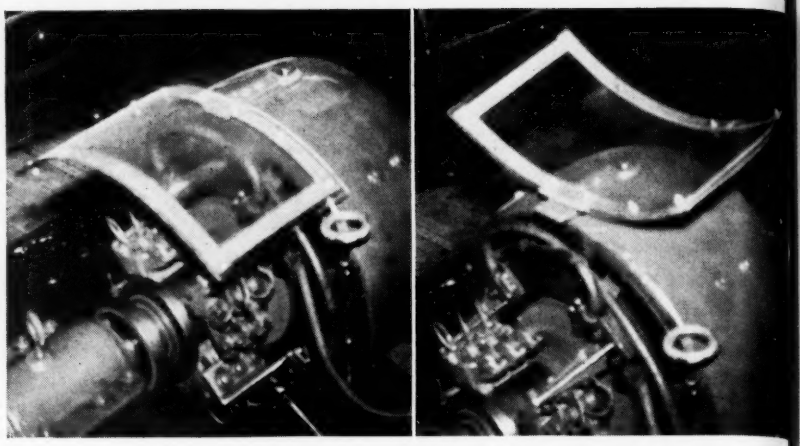


Fig. 1A—left. This photograph shows the hood over the exciter lowered into place. Fig. 1B. When the machine is down for servicing the hood is turned back out of the way

DUST SHIELD FOR EXCITER

By John F. Slavinsky

AN ENGINEER constantly is confronted with problems of preventive maintenance. As an example: for some time we had been having trouble with dust which collected on the exciter commutators. These exciters are direct-connected to our turbines and, with a speed of 3600 rpm, any particles of dust or grit that fall on the commutators have a highly abrasive action and they subject the brushes and commutators to excessive wear.

After considering different ways of stopping this nuisance I thought I would try making up a dust shield that would be compact and not prevent the operator from checking the operation of the machine. We finally decided to go modern and use plastic; the reason for this choice was that plastic is virtually unbreakable.

We made up a bracket to bolt on the exciter frame with a hinge and frame using DuPont Lucite bolted on with brass stove bolts. When the machine is in operation the shield is lowered (Fig. 1A) over the exciter and when the machine is down for servicing the shield is turned over on its hinge out of the way (Fig. 1B).

This method permits the operator clear vision of the brushes at all times. Should it be necessary to take the shield off the exciter frame all that is necessary is to remove the one bolt that holds it on the frame.

PRIMING A DIESEL COOLING WATER SYSTEM

By T. F. Cunningham

ON A DIESEL dredge boat where I was once a watch engineer, we had considerable trouble in priming the auxiliary engine (Diesel) for the water cooling system. Although the suction pipe had a foot valve on the end of it, trouble still existed when starting it up, so I conceived the idea of installing a tank on the roof of the boat, with a two-inch water line from it to the discharge line leading from the engine. As soon as the water was expelled at the end of the discharge pipe (which was visible to the engineer) the valve between the

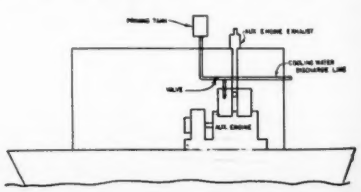


Fig. 1. Showing location of priming tank on roof of dredge

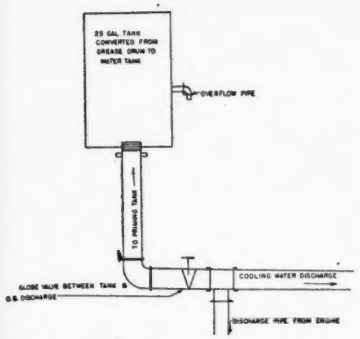

25 GAL. TANK CONVERTED FROM GREASE DRUM TO WATER TANK
OVERFLOW PIPE
TO PRIMING TANK
GLOBE VALVE BETWEEN TANK & G.S. DISCHARGE
COOLING WATER DISCHARGE
DISCHARGE PIPE FROM ENGINE

Fig. 2. Sketch showing details of tank and piping

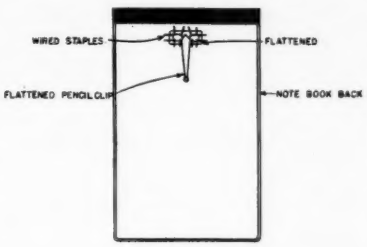
tank and discharge pipe was closed and the cooling system water was flowing.

After the water was circulating for a few minutes the tank could be filled by opening the same valve on the line between tank and the discharge piping. This was only a temporary hook-up as material for the piping was ordered so as to renew all water lines, but it solved the priming need. When the tank overflowed it ran off the roof back into the river.

Before this tank was installed it meant that the engineer on watch had to prime the line with a bucket of water and if it took the prime on the first bucket full it meant he got a bath because the union on the piping had to be uncoupled and while getting this together there was plenty of water flying. An enlarged sketch shows just how it worked after it was installed.

NOTE BOOK CLIP

AN ORDINARY pencil clip flattened and attached to a note book with wire



staples will provide a convenient means of keeping the notebook in the pocket.

of order resulted in the discovery that a rat (very dead) had chewed the high tension wires in half.

On another occasion, a service man, answering a call to an ice cream storage cabinet where the ice cream was rapidly returning to its original liquid state, discovered that the cause of the machinery shutdown was a little mouse who had been intrigued by the spinning blades of the condenser fan and decided to take a ride on them.

At a large industrial plant a short-circuit developed in a power transformer and shut down an important section of the plant, resulting in a hurried investigation by engineers of the plant and the electric power company. The answer? You guessed it—Mr. Rat on a trip of exploration into the realms of electrical science.

OH! THE LIFE OF AN ENGINEER

By C. E. Walters

I

WHEN we were kids, we'd peek inside,
At the engine with some fear;
And watch the wheels go 'round and 'round,
Oh! The life of an Engineer.

II

The pistons moving back and forth,
The governor and its gear;
How often you have said these words,
Oh! The life of an Engineer.

III

But little did you realize,
What went with that career,
For if you did, you wouldn't say,
Oh! The life of an Engineer.

IV

When other folks have gone to bed,
To pound a weary ear,
He's leaving home to go to work,
Oh! The life of an Engineer.

V

He oils 'er up, she's running fine,
So good he'd like to cheer;
The fireman yells the water's gone,
Oh! The life of an Engineer.

VI

Holidays or Sundays, all are the same,
On the job he must appear;
He's working while you're having fun,
Oh! The life of an Engineer.

VII

There's times he just gets into bed,
When his wife says, John my dear;
Big Joe is sick, come back to work,
Oh! The life of an Engineer.

VIII

He studies steam and Btu's,
And fuels from far and near;
It's study, study, all his life,
Oh! The life of an Engineer.

IX

He goes to meetings and what not,
To try to get it clear;
Just how to save his boss some dough,
Oh! The life of an Engineer.

X

So when you peek inside again,
Please do not let me hear;
You ever say those words again;
Oh! The life of an Engineer.

LETTERS AND COMMENTS

BOYLE, CHARLES AND GRAHAM

I WISH to comment on the question concerning the laws of Boyle, Charles, and Graham on page 96 in the January issue.

Mr. Shaffer has assumed that the liquid ammonia will evaporate when the valves are opened. This is not the case as a reduction in pressure will be necessary to cause this evaporation at constant temperature. The liquid ammonia will flow through the lower pipe until its level is equalized in the two tanks, air flowing through the upper connection. The air and ammonia gas will then diffuse through the upper pipe until the mixtures are uniform in the two tanks. The air will contribute 50 lb to the total pressure and the ammonia gas will contribute 50 lb. The pressures will remain at 100 lb in each tank, there will be no change in the quantities of liquid or gaseous ammonia, and there will be no external indication that any change has been made. However all three laws will be satisfied.

To get an increase in pressure Mr. Shaffer will have to raise the temperature and evaporate some more liquid, for 150 lb this temperature will be 84.4 F. Even at this temperature all of the liquid will not evaporate because the increase in air temperature will contribute a slight increase in partial pressure.

Rock Hill, S.C. J. C. PORTER

RATS AND VOLTS

By John Henry

WHEN RATS and mice get mixed up with volts and watts the results are usually disastrous for the animals and troublesome for the owners of the equipment involved.

A trouble call to a Neon sign out

Questions And Answers

Question No. 379

WHAT FLOOR PAINT WILL RESIST CREOSOTE?

IN OUR PLANT we try to do good housekeeping, therefore painting of floors and equipment is being given increased attention. The fine color pictures shown recently on the covers of POWER PLANT ENGINEERING have encouraged us to consider new and more attractive color schemes around our plant.

The exterior of a retort house in one of our plants is painted aluminum, also the tanks. Window and door trim are black. Inside the same retort house, the floor is painted red, the pumps are gray, the tanks are aluminum and black.

However, when a gasket blows out and creosote leaks out onto the floor it is hard to clean up. Also it discolors the floor paint. Have Q & A readers any suggestions about this? Also what colors are other plants using on motors, pumps, piping tanks, etc.?

Chicago, Ill. E.L.B.

Question No. 380

TRAPS FOR LARGE RETORTS, VALVES FOR CHEMICALS?

IN ONE OF our plants we have a process for the artificial seasoning of timber in steam cylinder retorts. These retorts are 100 in. in diameter, 120 ft long, operate at 200 psi.

In connection with the operation of these retorts, we have a number of piping problems and trapping problems on which we would appreciate Q & A readers comments.

The retorts are equipped with steam heating coils and it has always been something of a problem for us to work out the proper trap sizes for them, although the operating conditions are not out of the ordinary. Any comments you can give us on this matter of trap sizing for this application will be greatly appreciated.

We also have the problem of corrosion of valves and fittings in pipe lines handling special fire retarding solutions. These solutions contain ammonium sulfate, ammonium phosphate, boric acid and borax. We are trying out 18-8 metal, monel and other alloys and will welcome suggestions from engineers on how to beat this corrosion problem.

Chicago, Ill. T.E.H.

Question No. 381

HOW ELIMINATE CHEMICALS FROM WASTE WATER?

WASTE WATER from chemical process retorts in our plant is pumped into outside tanks. We are having difficulty in removing wood resins, oil, napthalene and other impurities from this water in the tanks. We have tried boiling them off, also using filters, and other devices. But none of these is really successful.

What methods have Q & A readers used on water clarification problems of this kind?

Chicago, Ill. E.R.N.

Question No. 382

HOW SHOULD HE LINE HOT-WATER STORAGE TANK?

WILL Q & A readers please give me information on lining a welded-steel, hot-water storage tank? Water temperature is 208-210 F. Tank is 7 ft in diameter, 11 ft high; steel is 3/16 in. thick.

I have in mind to secure metal lath to the sides of the tank and attach a cement lining to this, to act as a protective coating and prevent corrosion of the tank. If others have successfully used this method, I'd like detailed instructions.

The tank would be insulated on the outside and vented to atmosphere.

I had quotations to line the tank with sheet copper but the cost of that would be more than the cost of a new tank.

What about the cathodic protection system described in the June 1946 issue of POWER PLANT ENGINEERING? Also, could any kind of a protective paint or coating be sprayed or brushed onto the tank interior? Would these be better or cheaper than a cement lining?

Harrisburg, Pa. F.A.W.

Question No. 383

WHAT PUMPS AND CONTROL FOR THIS CIRCULATING WATER?

AT SEVERAL of the plants of our company located near the mouths of rivers, where the water level is affected by tides, we use a good deal of river water for condenser circulating water. We are not sure that we are using the best pumping hookup for supplying this water.

We would be particularly interested in getting Q & A readers' ideas about (1) what kind of pumps other engineers are using on jobs like this, where we have a lift of 16 to 20 ft and need to pump the water a distance of around 1000 ft; (2) what sort of automatic control should we use to be sure that these pumps, located at the river, start and stop when they should? How about gear pumps for this service?

Chicago, Ill. A.E.S.

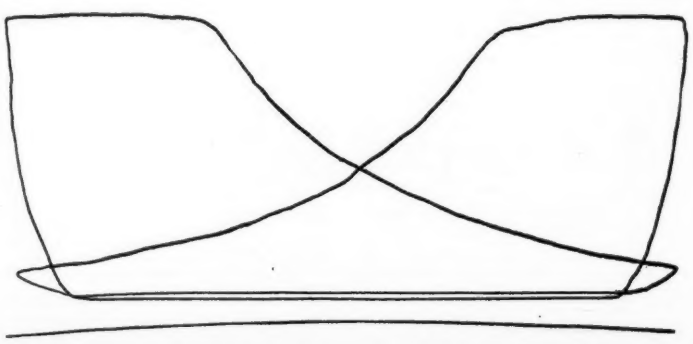
Question No. 384

HE WANTS COMMENTS ON DIAGRAMS FROM 50-YEAR-OLD CORLISS ENGINE

HERE ARE indicator diagrams from the high-pressure side of a Harris, cross-compound 18 by 32 by 48-in. Corliss steam engine that has been in continuous operation for 55 years. (We have blueprints of it dated 1892.) If Q & A readers have any comments, good or bad, I'd appreciate them. The engine runs cool and quiet now. After 50 years you can't expect too much of machines —or men either.

I would also like some comments on the best way to set the valves on the low-pressure cylinder of this engine. The engine is governed only on the high-pressure side. I regulate the receiver pressure by hand.

I hope there's room among the steam and gas turbines and atomic energy developments for an old-timer. (There certainly is.—Ed.) I saw the picture of that Skinner recently published. It had operated 45 years—mighty fine. But I suppose 50 years from now the steam turbine too will be old-fashioned.



Indicator diagrams, actual size, from high-pressure cylinder of J.C.'s 18-by-32-by-48-in. cross-compound Corliss. Steam pressure, 125 psi gage; speed, 70 rpm; indicator spring, 60 lb. Cylinder bore, hp, 18 in.; lp, 32 in.; stroke, 48 in. Curved atmospheric line on original diagram

I enjoyed especially "The Case of the Ailing Corliss."

New York J.C.

Editor's Note:—Some time ago, J.C. also asked us for some data on the Brown releasing gear with which the high-pressure cylinder of his engine is equipped. This was a special gear, often installed on Corliss engines in place of the original gear supplied by their manufacturers. There were two types of the Brown releasing gear but we found the one J.C. referred to in an issue of *The Engineer* (predecessor of POWER PLANT ENGINEERING) published in 1908. That issue contained a complete review of all steam engines being manufactured at that time. J.C. said that was exactly the gear he had. Now, how could he get spare parts for it if he ever needed them? Well—after 40 years—quite a problem. But we had a hunch, suggested it to J.C., he wrote and discovered a company that claims it can make parts for or overhaul any steam engine in operation today. If you need the name of this company, we'll send it on request.

Question No. 385

CAN THIS FAN BE IMPROVED—AND HOW?

THE ACCOMPANYING sketches show a fan proposed for use in a small oil burner. I would like to know how the efficiency and construction of this fan can be improved.

The fan must be stamped or formed out of a single piece of sheet metal, likely duralumin.

Conditions which cannot be altered are: motor speed, 1600 rpm; motor draws 24 watts; diameter of inlet to fan casing, 2½ in.; width of casing, 1$^{3}/_{16}$ in; outlet from fan casing, 1¾ by 2 in.; largest possible diameter of fan, 4½ in.

I have been told that this fan cannot be made because the metal will be distorted out of shape at the speed the fan will turn. I feel that if the fins are at the right angle to the center, the flow of the air will help to hold the fins in shape. Would this cause too much loss in the efficiency of the fan? I would also like the fan to be fairly quiet.

No doubt with all these restricting conditions, the fan could not be made with a very high efficiency but I would certainly appreciate any information you can give me as to size of fins, shape of fins, and position of fins in regard to the center of the fan.

Vancouver, B.C. J.C.E.

Answer No. 351

WHY DOES HE HAVE TO ROLL TUBES OFTENER?

Cuttitta Tells Just How He Rolls Tubes in Similar Boilers

I WOULD very much like to put my two cents' worth into the troubles L.L.C. has been experiencing with his boiler tube ends. This amplifies the very helpful comments given by several readers in the March issue.

Here at our plant we have twelve 150-hp HRT boilers, which are at this time kept in reserve. Prior to this, they were used during our heating season, and were required to go into service sometimes on five minutes' notice. They would run for a few hours and then come off the line. This condition would prevail throughout the entire heating season, so you can readily understand the tremendous stresses and strains these boilers had to contend with. Yet upon making our annual inspections, no sign of tube end leakage was discovered. Seven of these boilers were retubed in 1937 by a crew of men including myself. Here's the way we did it on these 7 boilers with 130 tubes per unit.

In all probability, the method used is standard practice, yet there is the possibility that L.L.C. may have overlooked something in rolling or renewing his tubes.

First, we were fortunate enough to have a welding outfit to be used mostly in cutting the tubes out. We did that working from bottom to top, so we could drop the tubes freely to the drum surface and pull them out through the bottom manhole. But one very important thing must be remembered—that is, to leave the two vertical center rows of tubes intact to prevent the boiler plates from bulging to any extent. This will also minimize the cutting of new tubes to be inserted to various lengths.

With all the old tubes out, except the two center rows, our next problem was to clean the entire drum surface, including the tube segments, either by hand-scraping or chipping, whichever was necessary. Fortunately again, we had a pneumatic scaling hammer that cut our work down over 50 per cent. With that work complete, a wire brush was used to clean up the remaining particles of scale and dust.

Now with the drums and tube segments cleaned of scale and dust to the metal surface, time was taken to check the stay-bolts, blow-off hole, internal feedwater line and water column connection, etc. With those thoroughly inspected, and the necessary repairs made, we applied a good coating of Apexior to the metal.

Now we were ready for our new tubes. A long substantial measuring stick was now brought in and with one man in front and one man at the rear end of the boiler, the stick enabled us to take precise measurements. Naturally this took time; but remember—a stitch in time saves nine.

As we commenced to insert each boiler tube, we were very careful about the clearance between the outer part of the tube and the tube hole on the boiler plate, to make sure that the clearance was not too great to warrant inserting ferrules. This, I might point out is very important. If the clearance should be greater than 1/64 of an inch, it would be advisable to insert ferrules, to assure an even roll on the interior of the tube, also to avoid excess rolling or thinning of the same.

Next we aligned and set our tube ends in proportion to each other, rolling both ends, working our tubes in from the outside to center. We were finally able to cut out and drop the remaining two center rows of old tubes. Adequate room was still available to scrape or chip the scale between the tube segments in that area, using the same procedure as before.

Now the boiler was completely retubed and rolled in on both ends and we prepared ourselves for beading. Before we proceed to that operation, we flare or bevel, if you care to call it that, the tube ends to avert cracking them in beading. This was accomplished by using the round part of a heavy machinist's hammer, although we had a regular flaring tool and could have used the same tube roller by merely pulling the expander out, clearing the boiler plate, injecting our mandrel and expanding our flare to any desired degree.

At this time I would like to suggest to L.L.C. that the Gustav Wiedeke Co. of Dayton, Ohio has a large variety of tube expanders. One particular item is their Ideal Superheater Form B Section Expander used for bracing tube sheets on both sides, raising a bead on the inside and flaring tube end to a de-

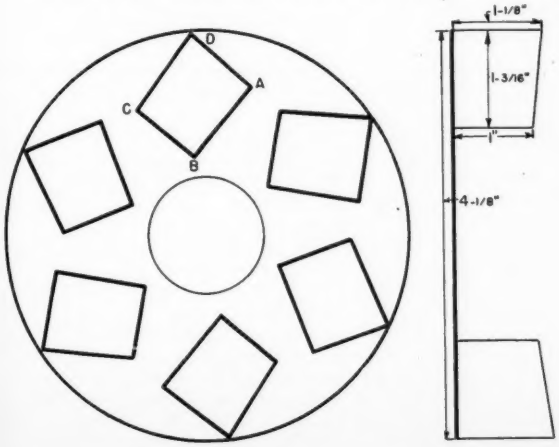


Fig. 1. J.C.E. asks if small fan can be made like this from a single piece of sheet metal

gree for easy beading. L.L.C. might try beading the inside as well as the outside of his tubes.

Now, to resume, we have just completed flaring our tube ends. We prepare ourselves for beading. Again we are fortunate enough to be equipped with a pneumatic beading hammer, although we have a hand beading tool in the event our hammer should fail us. Man! What a job it would be then!

The boiler is completely finished as far as the tubes are concerned, but to make sure that the first rolling in of the tubes was not disturbed, we roll them in once again. You may wonder why that should have to be done. Well, due to all the vibration created by the air hammer, etc. it is possible for the rolled-end tube to lose its joints.

With that completed, we turn to the remaining accessories of the boiler in preparation for the boiler inspector. Upon his arrival the interior of the boiler is checked to his satisfaction. The boiler is then closed and hydrostatically tested. With the inspector's approval, the boiler is then ready for service. The crew goes on to the next boiler setting and a repetition of the same job.

Passaic, N.J. A. F. CUTTITTA

Answer No. 360

CAN HE GET MORE POWER BY BALANCING UP 3-PHASE LIGHTING CIRCUITS?

Yes, He Should Use 3-Phase, 4-wire System, says Lanctot

YOU CERTAINLY do lose power by having an unbalanced system. An unbalanced system causes, for one thing, a poor power factor and, as a result, loss of power; or, conversely, increased cost for the same power.

In a problem of this nature, I would be inclined to use a 3-phase 4-wire 120/208 v system, using standard 110/220-v single phase transformers connected delta-star. This would not completely eliminate unbalance but would reduce it to a minimum. Three-phase 4-wire panels will be necessary for distribution purposes but only one set of feeders will be required, instead of three sets as in the case of single-phase 3-wire system. A 3-phase 4-wire system will give the added advantage of being able to operate small portable devices on 110 or 220 v or three-phase equipment on 220 v (208 v).

Further information on connection of single-phase loads to three-phase systems may be obtained from the General Electric Co.'s book No. GET-2B entitled "Transformer Connections."

Montreal 3, Canada R. LANCTOT

Answer No. 364

DOES HE NEED TO GET RID OF THE BOTTLENECK?

No, Says Andrews, and Gives Reasons

THE DIRECT answer to this question is "no." A radiator heating system operating at the maximum allowable pressure of 15 psig and delivering the required heating effect satisfactorily over a period of 30 years should require no alterations. With the steam traps in good condition, it may be assumed that condensate and fixed gases are removed effectively and therefore that all the radiant surface is active.

Since the four cast-iron radiators have a fixed internal volume and contain steam at the maximum allowable pressure, there is no possibility of getting a greater volume of steam into them without exceeding safe working conditions. The elimination of the steam supply line bottleneck is, of course, *theoretically* desirable for the reason that in any controlled flow system the regulating device functions best when it operates normally with a greater pressure drop than the total pressure drop in the connected piping system. However, in this case, where radiant atmospheric heating is involved, the excessive pressure drop in part of the supply piping has little practical importance for the reason that, in all probability, the regulating valve is the full 1½-in. line size as indicated on L.T.'s diagram.

Enlarging the 1-in. section of line would merely tend to cause the valve to wire-draw, which would lead to excessive maintenance and inferior control. Without making an illustrative calculation, it can be said that the best original design would have been the use of a 1½-in. steam supply line with a 1-in. regulator. Normally, the regulator should be smaller than the line but, as stated above, no change in the present piping would be worthwhile in this case.

In the event that the required heating effect were not obtained from the radiators, L.T. should look for some change in the heating duty or in the characteristics of the steam. Saturated steam transfers heat much more effectively than superheated steam, the superheat in the latter acting like a fixed gas. Accordingly, with highly superheated steam, more heat could be radiated by introducing a simple desuperheater in the system. Where cast iron is involved, this might also be important from a safety standpoint.

Roxana, Ill. GLENN N. ANDREWS

No, Leave It Alone, says Moulton

L. T.'s piping hook-up sure is one for Ripley; but, unusual as it is, it seems to work and that is what counts. The pressure is quite high for space heating, which would indicate too little radiation surface for the heating requirements.

The steam supply seems to be ample for the job, so there would be no point in changing the 1-in. line to 1½ in., because the pressure has to be reduced from 125 to 15 lb to supply the radiators and the 1-in. section helps out the reducing valve.

The net result is less radiation loss due to the small diameter and higher velocity of steam flow, therefore it seems to serve the purpose just as it is.

Pittsfield, Mass. ALBERT H. MOULTON

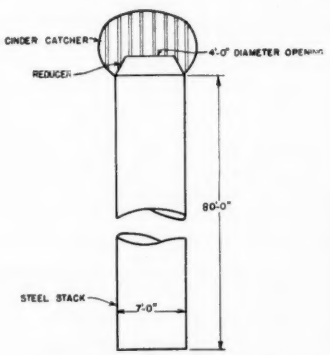
Answer No. 367

WHY DOESN'T THIS CHIMNEY PRODUCE ENOUGH DRAFT?

A CHIMNEY can be too large for certain conditions. In the case given, it is evident without any further calculation that the 7-ft steel stack is too large in diameter but too short to give the necessary draft. It would seem, at first thought, that the larger the diameter the more gas it would carry away and so give a better draft; but while it is true that area does give carrying capacity, draft intensity depends upon chimney height.

As an illustration, let's suppose that we replace the 7-ft diameter stack with one several times that diameter; we would soon reach the condition of having no stack at all, because at this point the stack effect would be all or nearly all lost. In fact, we might just as well let the boiler breeching empty directly out of doors, for all the good that kind of stack would do us.

Of course, we must not jump to the conclusion that the smaller the stack is, the better; because, like a pipe, a stack must have enough area to give it the required carrying capacity. Taking an outside temperature of 60 F and stack temperature of 500 F, the draft for each foot of height is generally taken as 0.0064 in. of water. Then a stack 80 ft high would have a static draft of $0.0064 \times 80 = 0.5120$ in. but, due to its large area with consequent low velocity, it will not be over 0.3100 in. and may be much lower, because of air leakage, excess air etc. (the cinder catcher might have some effect too).



Moulton suggests a reducing ring at stack top to improve L. H.'s chimney

If the stack is very old, it would not pay to put in a partition to reduce the area, for that would be a rather expensive job and steel stacks are not too long-lived.

One of 3 things could be done to remedy the trouble: (1) Replace the present stack by one of the right size and height to give the required draft, or (2) install induced draft to help out present stack or (3) perhaps, more or less as an experiment, put a reducing ring around the top as in the sketch, to reduce area and increase gas velocity.

Pittsfield, Mass. ALBERT H. MOULTON

Answer No. 368

WHAT IS BEST CLEANING MATERIAL FOR FREON-12 CONDENSER?

IN THE March issue, H. B. asked which of the following fluids should he use to clean a Freon-12 shell and tube condenser: water, Freon-12, ammonia, carbon dioxide, sal soda, carbon tetrachloride? Two answers are given below.

We referred this question to a local engineer who has operated and maintained a great deal of refrigeration equipment, including much Freon-12 equipment. This engineer says that in his opinion the Freon-12 itself is the best cleaner. He says further that if dirt is found on the Freon-12 side of the condenser, it is coming in from some outside source in greater quantities than the Freon is able to handle and the condenser itself is acting as a dirt trap or pocket. If so, he says, the obvious solution is to find where the dirt is coming from and eliminate it. If for any reason this cannot be done, install a filter of some kind ahead of the condenser. What do other readers think of this explanation?

Water, Says Bailey

IN ANSWER to this question, I suggest that H. B. use a water lance for cleaning the condenser shell and a water lance and soft rubber plugs for cleaning the condenser tubes.

Care must be taken, though, when cleaning the tubes, that the protective film of corrosion products on the inner surfaces of the tubes is not destroyed during the cleaning process.

Stratford, Conn. ALFRED F. BAILEY

Carbon Tetrachloride, Says Wilkes

CARBON Tetrachloride is the best fluid to use for cleaning the Freon-12 condenser.

Oaklyn, N.J. C. A. WILKES

Answer No. 370

HOW DEFINE PER CENT OF BLOWDOWN?

SHOULD the amount of blowdown be expressed as per cent of steam flow from the boiler or of feedwater flow into the boiler? asked D.R. in the March issue. Here's what readers say.

Comment By Alleman

THE PER CENT of blow down is usually expressed by the formula:

$$\left(\frac{\text{Quantity of water blown from boiler}}{\text{Quantity of boiler feedwater}}\right) \times 100 = \text{per cent blowdown}$$

Thus a 5-per-cent blowdown means that 5 per cent of the water fed to the boiler is removed by blowdown.

Minnesota City, Minn. GLEN ALLEMAN

Comment By Osborn

Boiler blowdown is usually expressed in percentage and is defined as follows:

$$\left(\frac{\text{Quantity of water blown from boiler}}{\text{quantity of boiler feedwater}}\right) \times 100 = \text{per cent blowdown}$$

Algebraic proof of blowdown formula:

x = quantity of feedwater

y = quantity of blowdown water

a = chloride concentration in feedwater

b = chloride concentration in boiler water

k = per cent blowdown

Therefore by definition of per cent blowdown $k = \frac{100\ y}{x}$. Since the total chlorides entering boiler must equal total chlorides leaving boiler, $xa = yb$. Multiplying both sides of that equation by $\frac{100}{xb}$, we obtain $\frac{100a}{b} = \frac{100y}{x}$

Since by definition $\frac{100y}{x} = k$ then $k = \frac{100a}{b}$ or $\left(\frac{\text{chlorides in feedwater}}{\text{chlorides in boiler water}}\right) \times 100 = \text{per cent blowdown.}$

South Bend, Ind. R. OSBORN

Comment By Parks

THE per cent of blowdown is always calculated in per cent of feedwater fed to the boiler. If 50,000 lb of feedwater are fed to a boiler and only 47,500 lb of steam are recorded, then 50,000 — 47,500 is 2500 lb of water blown down, provided there are no leaks, and (2500 ÷ 50,000) × 100 is 5 per cent blowdown.

In some plants, where the method of treating the feedwater and the condition of the water is fairly constant, the per cent of blowdown is once accurately determined and then used in all calculations thereafter. This is done to compensate for leakage or losses other than blowdown. These may be when the feedwater heater or storage tank overflows or from leaky stuffing boxes on valves and pumps. Otherwise we may be charging to the boiler for water that leaked out before it reached the boiler at all. The primary purpose of determining the per cent of blowdown is for heat balance calculations and the important thing is to know the amount of water really turned into steam.

Baltimore, Md. CHAS. W. PARKS

Comment By Pef

AS FAR AS I KNOW, the expression "per cent of blowdown" has not been standardized as to whether it is to be on the basis of the steam or on the basis of the feedwater. Since most boilers are equipped with steam meters but not so many with feedwater meters, I suppose most engineers express the blowdown as per cent of the steam, since this requires simplified calculation.

If B represents the amount of blowdown and S the amount of steam, the equation for the blowdown in per cent of the steam is:

$$100\ B \div S$$

and in per cent of the feedwater:

$$100\ B \div (S + B)$$

If the blowdown is 10,000 lb per hr and the steam generated 100,000 lb per hr, the per cent of blowdown is:

(100 × 10,000) ÷ 100,000 = 1 per cent of the steam

or

(100 × 10,000) ÷ (100,000 + 10,000) = 9.1 per cent of the feedwater

On the other hand, if the blowdown is 50,000 lb per hr, it will be 50 per cent of the steam and 33 per cent of the feedwater.

It is seen from the above calculations that when the blowdown is small, the results are about the same whether they are expressed in terms of the steam or the feedwater, but that as the blowdown increases the difference increases and it becomes more important to know whether the blowdown is on the basis of the steam or the feedwater.

With most boilers the blowdown is seldom over 10 per cent and for approximate calculations most engineers fail to state on what basis the blowdown is expressed, but I believe that this should be standardized.

Blowdown is not a phase of boiler operation alone but has applications wherever liquids increase in concentration and have to be diluted. For instance, in water cooling towers, the blowing down in some cases is more than 100 per cent of the vapor produced, but if expressed in terms of the feedwater it will be 50 per cent, and it makes a difference whether the blowdown is really 100 per cent or 50 per cent.

It is my belief that the blowdown should be on the basis of the feedwater, for then it will be of general application both for boilers and for process, such as water cooling towers, where the amount of vapor produced is hard to determine and only the make-up water is known.

At the present time, most engineers in writing about blowdown fail to state whether it is on the basis of the feedwater or steam. If an increasing number of engineers will state the blowdown not as so much per cent but as "blowdown, per cent of feedwater," which I believe is the logical basis on which to express it, in time the term will become standard by usage.

Dorchester, Mass. N. T. PEF

Editor's Note:—

Mr. Pef is certainly right; the subject and definition does need some standardization.

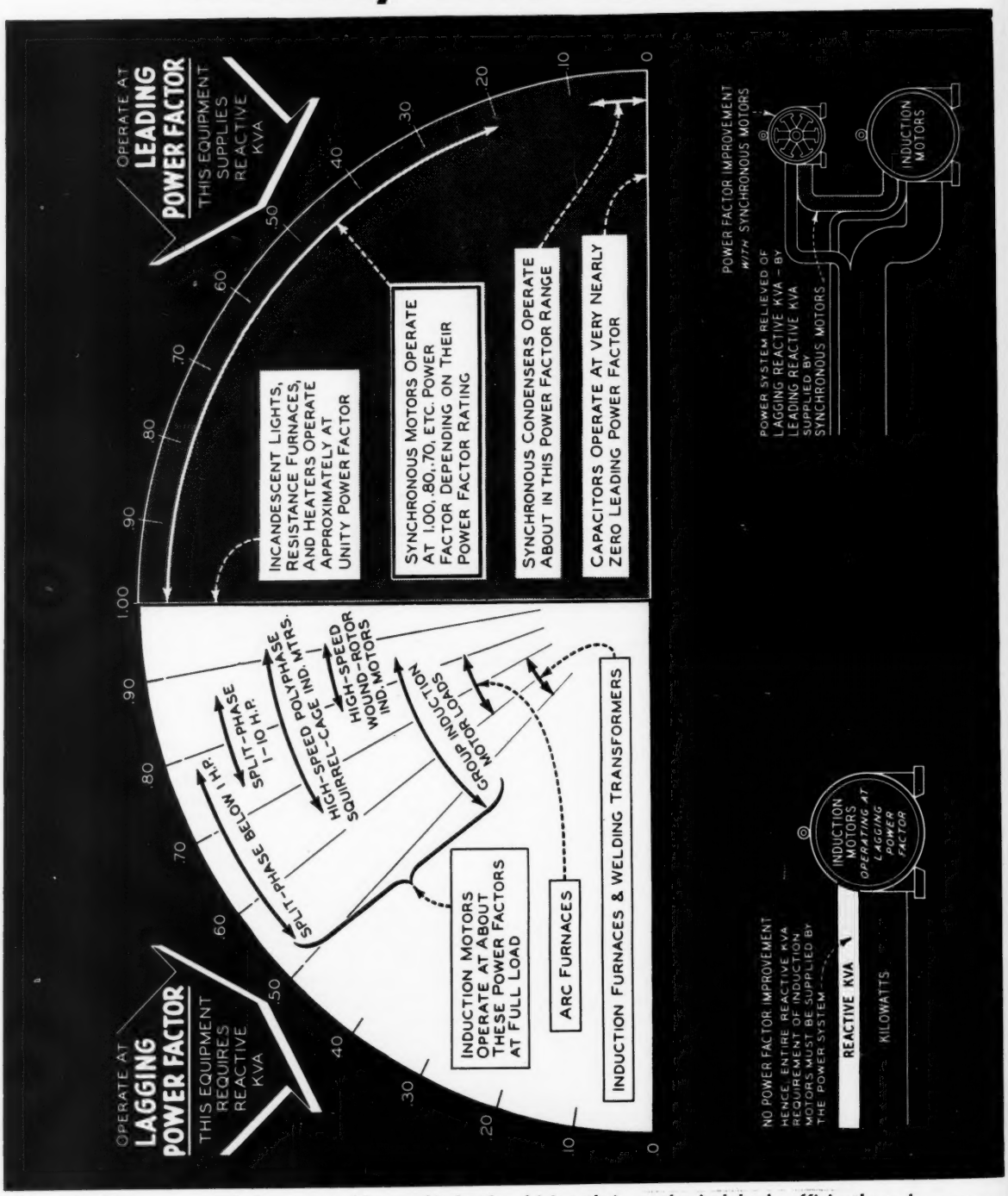
Only one of the above comments, that by Mr. Osborn, brings in the question of concentration. One engineer has suggested to us that, since the purpose of blowdown is to reduce the concentration of the boiler water and replace it with water of lower concentration, this concentration is the proper basis for comparison. This is done either by intermittent or continuous blowdown.

In either case, he states, the amount of blowdown in per cent of feedwater necessary to maintain a desired concentration in the boiler would be:

$$\frac{\text{Concentration of feedwater in ppm}}{\text{Concentration of boiler water in ppm}} \times 100 = \text{per cent blowdown}$$

Since this concentration is proportional to the quantities of water, its expression in those water quantities is correct, as Mr. Osborn has shown. The point is that we should remember the real purpose of blowdown: to maintain a desired concentration in the boiler water.

A Handy Power Factor Pie


OPERATE AT LAGGING POWER FACTOR
THIS EQUIPMENT REQUIRES REACTIVE KVA
OPERATE AT LEADING POWER FACTOR
THIS EQUIPMENT SUPPLIES REACTIVE KVA
1.00
.90
.80
.70
.60
.50
.40
.30
.20
.10
0
INCANDESCENT LIGHTS, RESISTANCE FURNACES, AND HEATERS OPERATE APPROXIMATELY AT UNITY POWER FACTOR
SYNCHRONOUS MOTORS OPERATE AT 1.00, .80, .70, ETC. POWER FACTOR DEPENDING ON THEIR POWER FACTOR RATING
SYNCHRONOUS CONDENSERS OPERATE ABOUT IN THIS POWER FACTOR RANGE
CAPACITORS OPERATE AT VERY NEARLY ZERO LEADING POWER FACTOR
SPLIT-PHASE BELOW 1 H.P.
SPLIT-PHASE 1-10 H.P.
HIGH-SPEED POLYPHASE SQUIRREL-CAGE IND. MTRS.
HIGH-SPEED WOUND-ROTOR IND. MOTORS
GROUP LOADS
MOTOR LOADS
INDUCTION
INDUCTION MOTORS OPERATE AT ABOUT THESE POWER FACTORS AT FULL LOAD
ARC FURNACES
INDUCTION FURNACES & WELDING TRANSFORMERS
POWER FACTOR IMPROVEMENT WITH SYNCHRONOUS MOTORS
POWER SYSTEM RELIEVED OF LAGGING REACTIVE KVA - BY LEADING REACTIVE KVA SUPPLIED BY SYNCHRONOUS MOTORS
INDUCTION MOTORS
NO POWER FACTOR IMPROVEMENT
HENCE, ENTIRE REACTIVE KVA REQUIREMENT OF INDUCTION MOTORS MUST BE SUPPLIED BY THE POWER SYSTEM
INDUCTION MOTORS OPERATING AT LAGGING POWER FACTOR
REACTIVE KVA
KILOWATTS

Your electric power supply has to provide two kinds of power: useful kilowatts that do actual work, and "dead-head" reactive kva (kilovars) needed for magnetizing induction motors and other inductive equipment on your system. This reactive power merely surges back and forth between the source of reactive power and the inductive equipment. Both must be paid for though one is a "dead horse."

The use of synchronous motors can help to overcome the low power factor problem because in addition to driving their mechanical loads efficiently and economically, they can also furnish extra magnetizing kva to take care of inductive load requirements. This takes some of the load off the power supply, which then has greater capacity for delivering useful kilowatts to your motors. The result is a higher power factor . . . which in many instances assures a saving in power rates, and better motor performance. This chart furnished by Electric Machinery Mfg. Co. will help you in determining how synchronous motors can reduce costs.

XUM

Automatic Switching Schemes For Capacitors

Need for varying the amount of capacitor kvars in accordance with variations in load . . . Use of automatic switching . . . Indirectly connected capacitors — variable voltage method . . . Directly Connected capacitors . . . Switching in equal or unequal steps . . . Switching capacitors by means of motors . . . Effect of capacitors on voltage regulation

By W. H. CUTTINO, Westinghouse Electric Corporation, East Pittsburgh, Pa.

IMPROVEMENTS IN DESIGN and reduction in cost within the past ten years have given increased recognition to the capacitor as an efficient, economical, and reliable generator of kvars. The reduction in cost and increase in reliability resulted in more application investigations which revealed the economic possibilities of the capacitor as a useful tool for releasing system capacity, improving voltage regulation, reducing losses, and improving power factor.

The recognition of these many benefits has led to a rapid increase in the size and number of capacitor installations. When more and more capacitors are added to a system with widely varying loads, a situation may be reached where their effect becomes objectionable during certain operating conditions. It is, therefore, desirable to obtain the benefits of additional capacitor correction without the objectionable features. The maximum benefits can be obtained by adjusting the capacitor kvars to the correct value at the proper time. When capacitor kvars installed are greater than the light load reactive kvars, it is usually desired to have the capacitor kvars reduced at light load to avoid objectionable overvoltage or excessive leading kvars. The line losses are at a minimum when the capacitor kvars are the same as the load kvars. If voltage regulation is the primary objective, then the capacitor kvars should be adjusted to hold the circuit voltage within the set limits. Unlike the ordinary voltage regulator, however, the adjustable capacitor improves the voltage regulation on both the supply and load side by reducing the current flowing in the supply feeders. If the primary objective is to keep the kva demand to a minimum or to keep the overall power factor within certain limits, the capacitor kvars may be adjusted in response to a kvar regulating relay or a power factor regulating relay. When the need for adjustable capacitor kvars is established, then the question arises as to the most economical arrangement that will give the desired operating results.

The capacitor kvars may be automatically adjusted by varying the voltage on the capacitor or by varying the amount of capacitors connected to the circuit. The amount of capacitors may be varied by automatically switching in equal or unequal steps in response to circuit conditions or they may be switched by the same switching means controlling the load for industrial plants. Switched capacitors may also be used to efficiently increase the effective range of a voltage regulator. In some instances, it is desired to have a kvar generator which can furnish leading and lagging kvars. This may be accomplished by a combination of capacitor, reactor, and automatic tap changing transformer; by a combination of capacitor and synchronous condenser; or by a combination of directly connected capacitors and reactors. These various schemes will now be considered.

The benefits of capacitors in power factor correction are well known. When more and more capacitors are added to a system, however, a condition may be reached where their effect becomes objectionable under certain conditions of load. It, therefore, becomes desirable to provide some method of switching capacitors in and out of the circuit with varying loads. This, naturally, should be done automatically. In recent years a number of different methods for the automatic control of capacitor installations have been developed. In this article which is an abstract of a paper presented by the author before the winter meeting of the American Institute of Electrical Engineers, a number of these methods of switching are described. Users of capacitors in large industrial plants should find these methods of interest since each method had its peculiar advantages and one should be familiar with all of them in order to know which method is best for certain conditions

Indirectly Connected Capacitors

Variable Voltage Method

It is well known that the kvars supplied by a given size capacitor vary as the square of the voltage applied. Consideration has, therefore, been given to varying voltage applied as a means of adjusting the capacitor kvars. The voltage applied to the capacitor may be varied by means of a tap changing transformer as illustrated in Fig. 1-A or by means of an induction regulator as shown in Fig. 1-B. By the use of either of these methods, the capacitor kvars can be readily adjusted into small increments. The losses of the transformer or regulator add to the capacitor losses to substantially increase the overall losses for the installation.

In general, reasonably coarse adjustment of the capacitor kvars is found to be entirely satisfactory and the cost of directly connected capacitors with switches for each step is less expensive than the combinations of capacitor with tap changing transformer or capacitor with induction regulator.

If the repetitive switching duty on the breakers for directly connected capacitors cannot be tolerated because of a highly fluctuating load, then consideration should be given to capacitor with tap changing transformer or capacitor with induction regulator. In this connection, it should be remembered that if multi-step automatic control is used to initiate the adjustment of capacitor kvars, the kvar increments should be in equal steps. To accomplish this with a tap changing transformer requires voltage steps of unequal values because the capacitor kvars vary as the square of the voltage applied. If the capacitor

kvars are to be varied in 12½ per cent steps from zero to 100 per cent, then the voltage steps must be 0, 35.4, 50, 61¼, 70.8, 79, 86.7, 93¾, and 100 per cent.

Directly Connected Capacitors

SWITCHED IN EQUAL OR UNEQUAL STEPS

The capacitor kvars are usually adjusted by switching the capacitors in equal steps as illustrated in Fig. 2-A with a circuit breaker for each step. The control with master relay which will most economically meet the operating requirements will determine whether the capacitors are switched automatically in response to voltage, current, kvar, or power factor. Voltage control may be used to remove capacitors at light load if the supply voltage is regulated and the bus voltage varies owing to regulation. It also may be used for switching capacitors to regulate the feeder or bus voltage. Current control may be used to remove capacitors at light load if the supply voltage is non-regulated and the load power factor is reasonably constant with variation in loading. Kvar control may be used to remove capacitors at light load when the supply or bus voltage is regulated or non regulated and also may be used for switching capacitors to regulate kvars or power factor. The band width or spread adjustment of the master relay of the automatic control panel must always be larger than the effect of the largest capacitor being switched. Maximum flexibility and minimum operating duty on the switch are, therefore, obtained by having the capacitors arranged in equal switching steps.

To obtain a finer degree of control, it is sometimes proposed to switch the capaciltors in unequal steps as illustrated Fig. 2-B. Although a maximum of kvar values can be obtained with a minimum number of switches, there will be many more instantaneous changes and some of these will be greater than if the capacitors were switched in equal values. The diagram Fig. 2-B shows how the capacitors may be divided into three unequal values of 14 per cent,

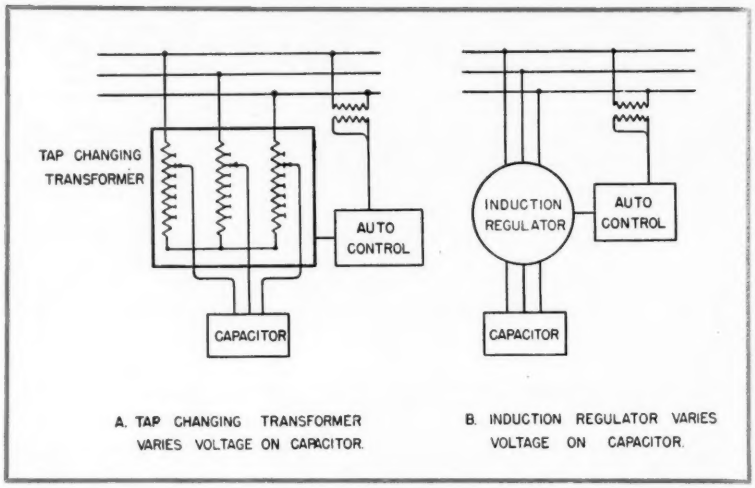


Fig. 1. Variable voltage method of condenser control is seldom used for adjusting capacitor kvars

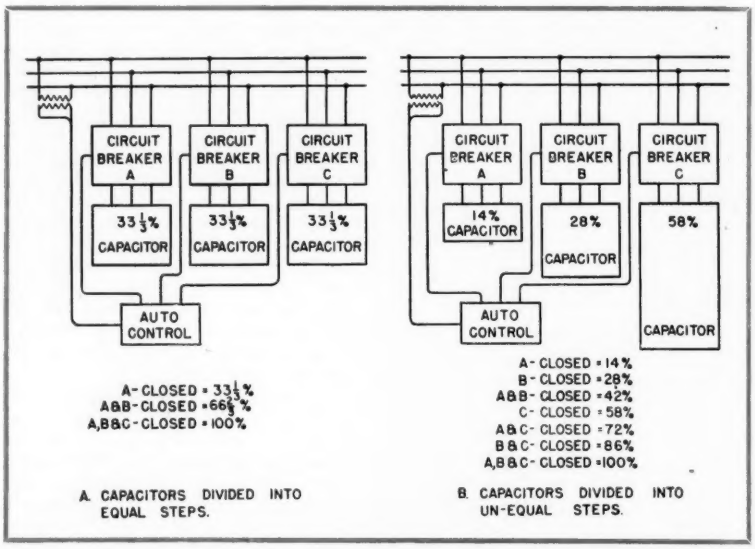


Fig. 2. Directly connected capacitors divided into equal switching steps is a common method of adjusting capacitor kvars. Capacitors divided into unequal switching steps is seldom used

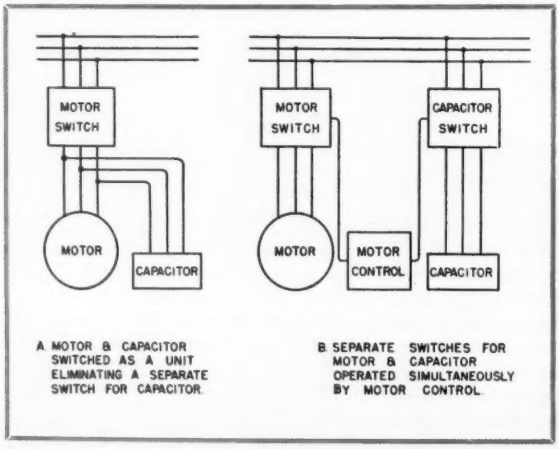


Fig. 3. Capacitors switched "on" and "off" with the induction motor for adjusting the capacitor kvars

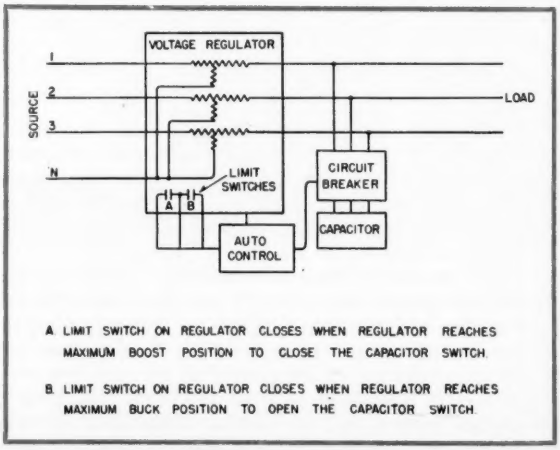


Fig. 4. Switching capacitors extend the effective range of the voltage regulator

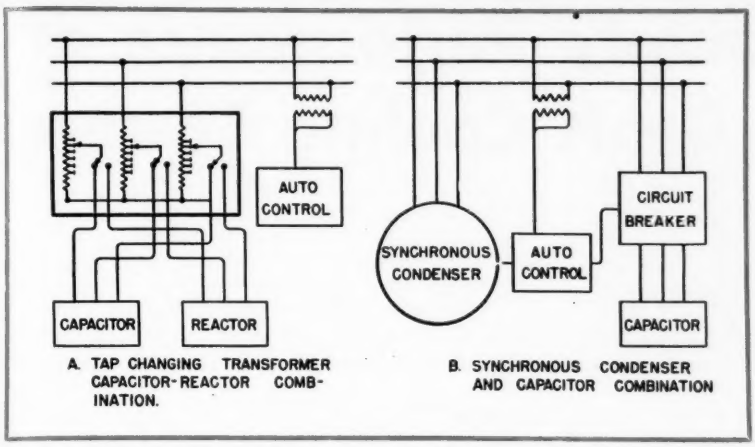


Fig. 5. Adjustable leading and lagging kvars provided by capacitor and reactor with tap changing transformer or with capacitor and synchronous condenser

28 per cent, and 58 per cent and switched to obtain seven values in steps of approximately 14 per cent. The maximum momentary disturbance occurs when switching from 42 per cent to 58 per cent when the C switch closes and the A and B switches open or when switching from 58 per cent to 42 per cent when the C switch opens and the A and B switches close. The increased number of switching operations inherent with this scheme cannot always be tolerated. There are twenty-two switching operations for one complete cycle of switching for the unequal steps as compared to six for the equal steps. The A switch of the unequal step group operates fourteen times during a complete cycle of switching while the A switch of the equal step group operates only twice.

SWITCHING CAPACITORS WITH MOTORS

In general, capacitors should be applied as near the load as practical. If it is found desirable to switch the capacitor with variation in load for an industrial plant, consideration should be given to distributing them out on the circuit and connect them directly to the motor terminals as shown in the diagram Fig. 3-A. The capacitors will then be switched "off" and "on" with the motor without additional switching equipment.

The size of the capacitor switched with the motor switch should be selected to avoid excessive overvoltage due to self-excitation and excessive transient torque. Charts are now available listing the maximum capacitor size that should be switched with a given size motor. When capacitors are connected to the motor terminals, the line current drawn is less than without the capacitors. The overload devices should, therefore, be selected on the basis of the reduced line current to obtain proper protection.

To avoid excessive overvoltage or excessive transient torque, it may be desirable in some cases to use a separate switch for the capacitor as shown in the diagram Fig. 3-B. In the interest of economy, the motor control may be used to initiate the opening and closing of the capacitor switch.

CAPACITORS INCREASE EFFECTIVE RANGE OF VOLTAGE REGULATOR

When a voltage regulator is used for regulating line voltage, its effective range can be increased by adding a switched capacitor. The capacitor, unlike the ordinary voltage regulator, improves the voltage on both the supply and load side of the installation by reducing the current flowing in the supply feeders and lowering the losses in the circuit. The adding or removal of the capacitor increases or decreases the general voltage level of the circuit a given amount.

The diagram Fig. 4 shows a regulator with limit switches arranged to initiate the closing or opening of the capacitor switch. When the regulator reaches the maximum "boost" position, the capacitor switch closes to increase the voltage level and the regulator then backs up until the regulating relay is satisfied. On the other hand as the regulator reaches the maximum "buck" position, the capacitor switch opens decreasing the voltage level and the regulator reverses its travel and backs up until the regulating relay is satisfied. If adding or removing the capacitor changes the voltage level 5 per cent, then the effective range of the regulator is changed by this amount.

Supplying Adjustable Leading and Lagging Kvars

CAPACITOR, REACTOR AND TRANSFORMER COMBINATION

Capacitors have been rapidly replacing synchronous condensers for providing bulk wattless power or kvars for voltage regulation and power factor correction. There are many applications of synchronous condensers at the ends of power transmission lines where it is necessary to adjust the kvars supplied over a wide range including positive and negative values. For this purpose, standard synchronous condensers are provided with 50 per cent lagging reactive capacity as well as 100 per cent leading reactive capacity and can be varied between these limits.

A capacitor, reactor, and tap changing transformer have been proposed for performing essentially the same functions as the synchronous condenser. One scheme is shown in the diagram Fig. 5-A. This involves a tapped shunt winding, a capacitor, a reactor, and a tap changing mechanism which can vary the capacity kvars from 100 per cent of the capacitor rating to zero by changing taps. A transfer switch is provided to transfer from capacitor to reactor when the tap changer reaches the bottom of the travel whereupon the same tap changer operating on the taps of the same shunt winding can be used to increase the lagging kvars from zero to full rating of the shunt reactor. If the capacitor kvar is 100 per cent and the reactor 50 per cent, this combination

(Continued on page 107)

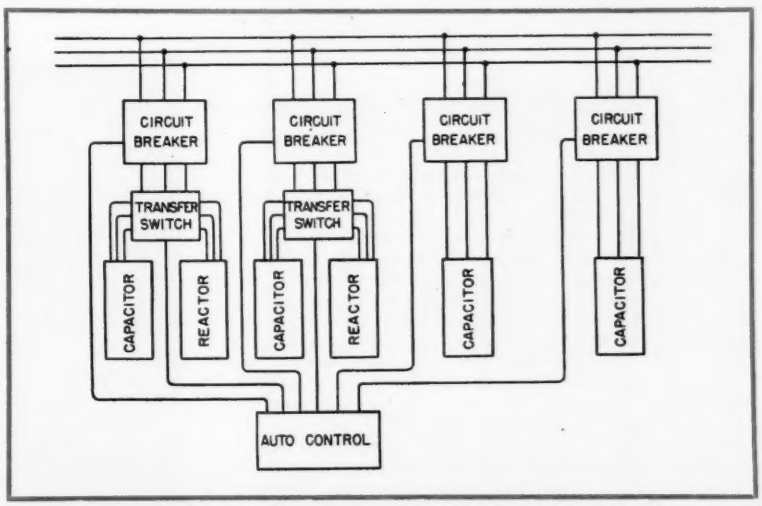


Fig. 6. Adjustable leading and lagging kvars furnished by switching directly connected capacitors and reactors

How To Evaluate Performance of Mechanical Draft Cooling Towers

By JAMES G. DE FLON

Chief Cooling Tower Development Engineer, The Fluor Corp., Ltd.

ALL THAT IS required to cool water is to expose its surface to air. Some cooling processes are slow, such as the cooling of water on the surface of a pond; others are comparatively fast, such as the spraying of water into air. These processes all involve exposure of water surface to air with varying degrees of efficiency.

The heat transfer process involves a latent heat transfer due to change of state of a small portion of the water from liquid to vapor, and a sensible heat transfer due to the difference in temperature of water and air. Approximately 1000 Btu are required to evaporate 1 lb of water; that is the amount of heat lost in cooling 100 lb of water 10 deg. Therefore, for each 10 deg of cooling, roughly 1 per cent of water is lost by evaporation. In addition, there will be a spray loss of not more than 0.2 per cent in a well-designed atmospheric or mechanical draft tower. Water, in cooling from 120 F to 90 F, for example, will therefore lose 3.2 per cent of its weight (3 plus 0.2) with each passage through the tower.

In cooling waters in which the water is warmer than the air, the heat removed from the water and transferred to the air is the sum of the sensible heat and the latent heat of evaporation. The sensible heat q_s is small compared to the latent heat transferred, wr. That is, $q_t = q_s + wr$ and $w = kA\Delta p_m$.

The factors that influence the performance of a cooling tower are therefore those which affect the expression $kA\Delta p_m$. The value kA depends on the construction of the equipment, the extent of water surface exposed through drop surface and filming surface, and the velocity of the air. The value Δp_m depends on the temperature of the water and the temperature and humidity of the air. Actually, Δp_m represents the difference in vapor pressure between the water at its temperature and water if it were at wet bulb temperature of air.

It is evident that the water cannot be cooled below the wet bulb temperature of the entering air. The wet bulb temperature, or to be more precise, the adiabatic saturation temperature, represents the minimum temperature that the water would reach with infinite time of contact between water and air in a cooling tower. This must be kept in mind when designing a plant to operate on cooling tower water.

General Considerations

As process refinements have appeared, industry has demanded closer and closer control of its production units, resulting in more exacting demands being made upon cooling towers. In many plants, each additional degree of cooling has meant hundreds and even thousands of dollars per day in increased production. It has, therefore, been necessary for the cooling tower industry to produce a tower which would supply the colder water more economically.

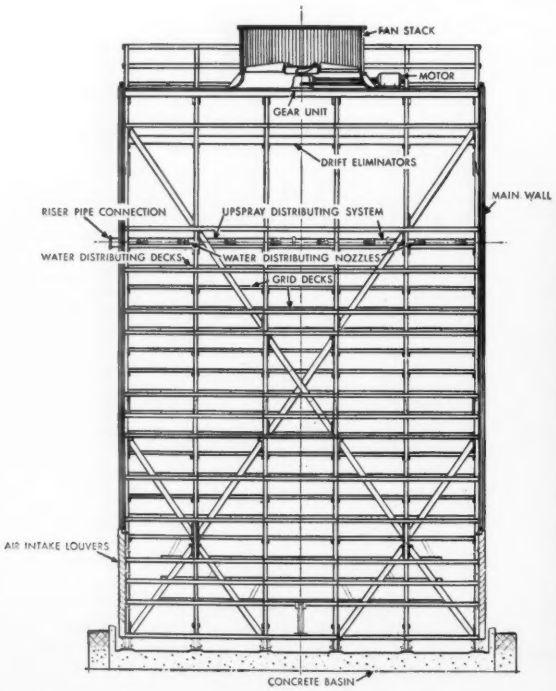
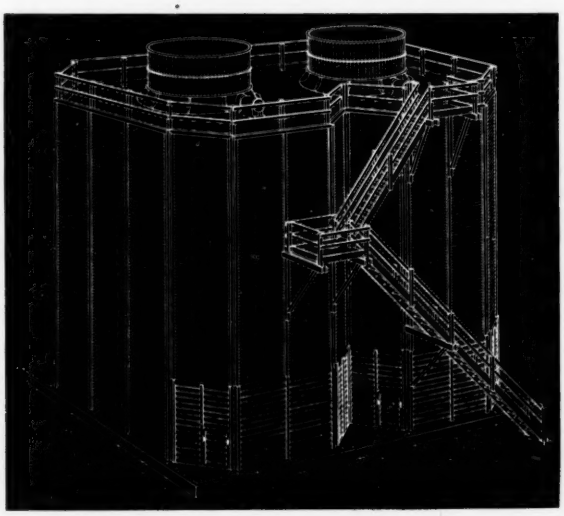


Fig. 1—left. Cross-section of mechanical induced-draft cooling tower. With upspray distribution system, it is necessary to allow sufficient space between drift eliminators and nozzles for a spray chamber Fig. 2. Modern 2-cell mechanical draft cooling tower; square corners removed to facilitate air distribution inside tower. Unit may also be installed over a coil shed to cool water which in turn may cool other water, liquids or gases circulated through coils



The plant operator, by the simple calculations and charts given here, can quickly estimate and compare performance of towers under various conditions . . . General principles of tower construction and operation . . . Relations between air and water temperatures, weights of air and water and contact time between water and air . . . Concentration of water, tower size and height, cooling range, approach to wet bulb temperature, water quantity, air velocity . . . How to find tower size and fan horsepower . . . How to calculate for different sizes of commercial towers . . . How to calculate for lower wet bulb temperatures . . . Estimating performance for other than design conditions . . . Variations in performance

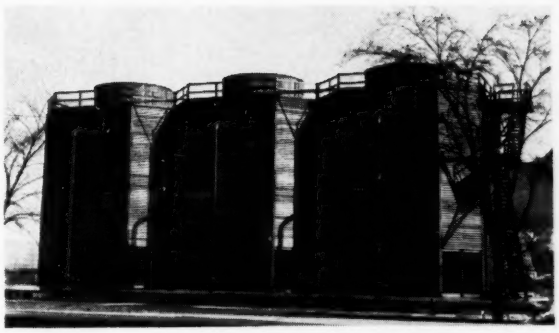


Fig. 3—above. View of a 3-cell mechanical draft cooling tower for a large tire company

Two types of cooling towers are in general use today—the atmospheric, to be discussed in another article and the mechanical draft, to be discussed in this article. Both types are capable of cooling water to the same minimum temperatures. The economic situation, the prevailing atmospheric conditions, the desired approach to the wet bulb temperature, and the amount of space available, will indicate which type to select.

Mechanical Draft Towers

Two types of mechanical draft towers are in use today—the forced draft and the induced draft. In the forced draft tower, the fan is mounted at its base and the air is forced in the bottom and discharged through the top at low velocity. In the induced draft tower, the fan is mounted on the roof of the structure and air is pulled upward and discharged at a high velocity.

The forced-draft type is more often subjected to the recirculation of the hot humid exhaust vapors back into the air intakes than the induced-draft type. This occurs under certain atmospheric conditions because the velocity of the humid exhaust air is so low that the suction created by the fans tends to draw it back into the tower. Since the wet bulb temperature of the exhaust air is considerably above that of the ambient air, there is a decrease in performance evidenced by an increase in cold water temperature.

Except for the location of the fans, the structural and operational features of the two types of mechanical draft towers are essentially the same. A cross-sectional view of the induced-draft tower with the various parts labeled is shown in Fig. 1. Entrained moisture is removed from the exhaust air by the drift eliminator, which is placed above the spray chamber and below the fan. The water is pumped to the main header located in the top of the tower where it is distributed to the various nozzles. This water is sprayed up in a manner similar to that used in a spray pond and is intimately mixed with the exhaust air before dropping to the decks below. (In performance, the upspray distributing system represents the equivalent of adding 8 or 9 ft to the height of cooling tower as compared with that of the gravity-type system).

The fall of the water is interrupted by the slat-type grids as it flows counter-current to the air. In flowing counter-current, the coldest water contacts the driest air and the warmest water contacts the most humid air. Maximum performance is thus obtained, since the temperature of all the cold water is approaching the wet bulb temperature of the entering dry air.

General Principles of Performance Calculations

The performance of a given type cooling tower is governed by the ratio of the weights of air to water and the time of contact between water and air. In commercial practice, the variation in the ratio of air to water is first obtained by keeping the air velocity constant at about 350 fpm per sq ft of active tower area and varying the water concentration (gal per min per sq ft of tower area). As a secondary operation, the air velocity is varied to make the tower accommodate the cooling requirement. The time of contact between water and air is governed largely by the time required for the water to discharge from the nozzles and fall through the tower to the basin. The time of contact is, therefore, obtained in a given type of unit by varying the height of the tower.

If the time of contact should be insufficient, no amount of increase in the ratio of air to water will produce the desired cooling. It it necessary, therefore, that a certain minimum height of cooling tower be maintained. Where a wide approach [1] of 15 F to 20 F to the wet bulb temperature and a 25 F to 35 F cooling range [2] is required, a relatively low cooling tower will suffice. A tower in which the water travels 15 to 20 ft from the distributing system to the basin is sufficient. Where a moderate

[1] The approach is the difference between the cold water temperature and the wet bulb temperature.

[2] The cooling range is the difference between the hot water temperature and the cold water temperature.

Fig. 4. Performance curves for sizing of mechanical draft cooling tower. Induced-draft type, with upspray distributing system, containing 24 ft of filling

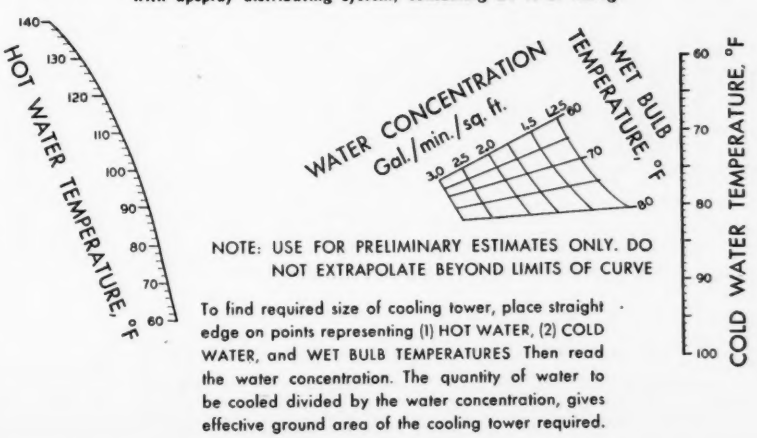


Fig. 4A. This auxiliary sketch pictures the manner in which the chart (Fig. 4) is used. See text for figures used in the example.

approach of 8 F to 15 F and a cooling range of 25 F to 35 F is required, a tower in which the water travels 25 ft to 30 ft is adequate. Where a close approach of 4 F to 8 F, with a 25 F to 35 F cooling range is required, a tower in which the water travels from 35 ft to 40 ft is required. It is usually not economical to design a cooling tower with an approach of less than 4 F, but it can be satisfactorily accomplished with a tower in which the water travels 35 to 40 ft.

Relations of the Various Factors

Figure 4 shows the relationship of the hot water, cold water and wet bulb temperatures to the water concentration. From this, the minimum area required for a given performance of a well-designed counterflow induced-draft cooling tower can be obtained. Figure 5 gives the horsepower per square foot of tower area required for a given performance. These curves do not apply to parallel or cross-flow cooling, since these processes are not as efficient as the counterflow process. Also they do not apply where the approach to the cold water temperature is less than 5 deg. These charts should be considered approximate and for preliminary estimates only. Many factors not shown in the graphs must be included in the computation, hence the manufacturer should be contacted for final design recommendations.

The cooling performance of any tower containing a given depth of filling varies with the water concentration. It has been found that the maximum contact and performance is obtained with a tower having a water concentration of 2 to 3 gal of water per minute per square foot of ground area. Thus, the problem of calculating the size of a cooling tower becomes one of determining the proper concentration of water required to obtain the desired results. A higher tower will be required if the water concentration falls below 1.6 gal per sq ft. If the water concentration exceeds 3 gal per sq ft, a lower cooling tower may be used. Once the necessary water concentration is obtained, the tower area can be calculated by dividing the gallons per minute circulated by the water concentration in gallons per square foot. The required tower size then is a function of the following:

1. Cooling range (Hot water temperature minus cold water temperature)
2. Approach to wet bulb temperature (Cold water temperature minus wet bulb temperature)
3. Quantity of water to be cooled
4. Wet bulb temperature
5. Air Velocity through the cell
6. Tower height

How to Calculate Performance

To illustrate the use of the charts (See Figs. 4A and 5A) let us assume the following cooling conditions:

Hot water temperature = 102 F
Cold water temperature = 78 F
Wet bulb temperature (T_{wb}) = 70 F
Gpm = 2000

Laying a straight edge across Fig. 4 and connecting the points representing the design water and wet bulb temperatures, we find that a water concentration of 2 gal per sq ft is required. Dividing the quantity of water circulated by the water concentration, we find that the theoretical area of the tower is 1000 sq ft.

To obtain the theoretical fan horsepower from Fig. 5, connecting the points representing the 100 per cent of standard tower performance with the turning point, we find that it will require 0.041 hp per sq ft of actual effective tower area. Multiplying by the tower area of 1000 sq ft we find that it requires 41.0 fan horsepower to perform the necessary cooling.

What To Do For Different Commercial Size Towers

But suppose that the commercial tower size is such that the actual tower area is 910 sq ft. We can still obtain the cooling equivalent to 1000 sq ft of standard tower area, by increasing the air velocity through the tower. Within reasonable limits, the shortage of actual area can be compensated for by an increase in air velocity through the tower which, in turn, requires a higher fan horsepower. Our problem then becomes one of increasing the performance of the smaller tower by 10 per cent. From Fig. 5, by connecting the points representing 110 per cent of standard tower performance and the turning point, the fan horsepower is found to be 0.057 hp per sq ft of actual tower area, or $0.057 \times 910 = 51.9$ hp.

On the other hand, suppose the commercial tower size is such that the actual tower is 1110 sq ft, the cooling equivalent to 1000 sq ft of standard tower area can be accomplished with less air and less fan horsepower. By the use of Fig. 5, the theoretical fan horsepower for a tower doing only 90 per cent of standard performance is found to be 0.031 hp per sq ft of actual tower area or a total of 34.5 hp.

This illustrates how sensitive the fan horsepower is to small changes in tower area. The importance of designing a tower which is slightly oversize in ground area becomes immediately apparent.

How Calculate for Lower Wet Bulb Temperature

Now let's assume that we have the same cooling range and approach as used in the first example, except that the wet bulb temperature is lower. The design conditions would then be: Gpm = 2000; Range = 24 F; Approach = 8 F; $T_1 = 92$ F; $T_2 = 68$ F; Wet bulb temp—(T_{wb}) = 60 F.

From Fig. 4, we find that the water concentration required to perform the cooling is 1.75, giving a theoretical

Fig. 5. Fan horsepower chart for mechanical draft cooling tower. Induced draft type, 24 ft of filling

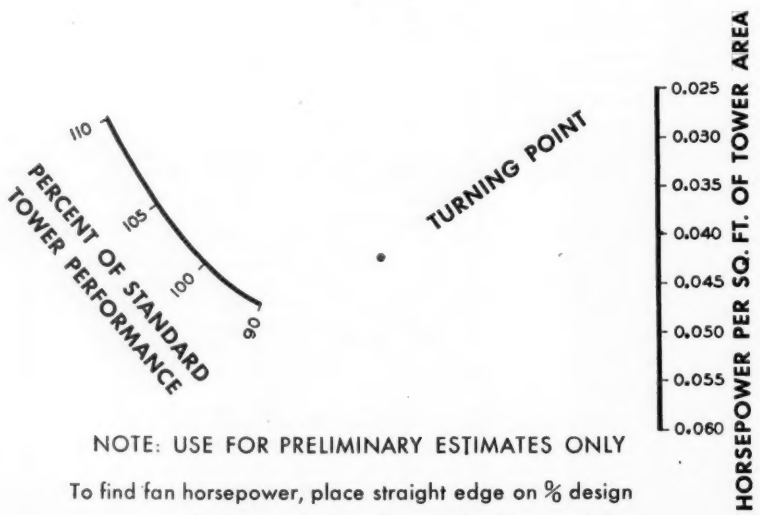
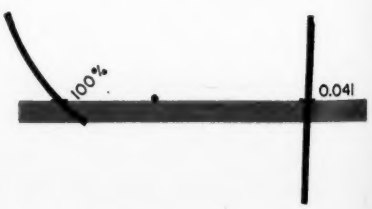

110
105
100
90
PERCENT OF STANDARD TOWER PERFORMANCE
TURNING POINT
0.025
0.030
0.035
0.040
0.045
0.050
0.055
0.060
HORSEPOWER PER SQ. FT. OF TOWER AREA
NOTE: USE FOR PRELIMINARY ESTIMATES ONLY
To find fan horsepower, place straight edge on % design tower capacity factor and turning point, then read fan horsepower per square foot of tower area at right. Multiply tower area by this factor to obtain fan horsepower.

Fig. 5A. Here is the worked-out problem given in the text. Use Fig. 5 when solving similar problems



tower area of 1145 sq ft as compared with 100 sq ft for a 70 deg wet bulb temperature. This shows that the lower the wet bulb temperature for the same cooling range and approach, the larger the area of tower required and therefore the more difficult the cooling job.

Estimating Performance for Other Than Design Conditions

The problem of estimating the performance of an existing tower at other than design conditions is often encountered by the plant operator. For example, suppose we have at tower that was designed for the following conditions: Gpm = 1000; Range = 30 F; Approach = 10 F; T_1 = 110 F; T_2 = 80 F; Wet bulb temp. = 70 F.

What will be the cold water temperature, T_2, when the wet bulb temperature, T_{wb}, drops to 60, provided, of course, that the heat load and water quantity remain constant? From Fig. 4, we find that the water concentration is 2.0 gal per sq ft at design conditions. This water concentration does not change, since the volume of water and the tower area remain constant. With the water concentration at 2.0 and the wet bulb temperature at 60 F, by adjusting the angle of the straight edge on Fig. 4 until we obtain a 30 deg differential between the hot water and cold water temperatures, we find the hot water temperature to be 103 F, and the cold water temperature to be 73 F.

Suppose, now, that the above designed tower had 1500 gpm flowing through it, and the total heat load remained constant, what would the cold water temperature be when the wet bulb temperature is 65 F? The design heat load was 1000 × 8.33 × 30 = 250,000 Btu per min.

The new cooling range (heat load remaining constant) when circulating 1500 gpm over the tower, would be 250,000 ÷ (1500 × 8.33) = 20.0 deg.

Theoretically, the design area of the tower from Fig. 4 was 500 sq ft (1000 gpm ÷ 2.0 gal per sq ft = 500 sq ft). The water concentration when circulating 1500 gpm is 1500 ÷ 500 = 3.0 gal per sq ft.

Now, referring to Fig. 4, with a water concentration of 3.0 gal per sq ft and 65 F wet bulb temperature, adjust the straight edge until a difference of 20 deg exists between the hot water and cold water temperatures. This shows the hot water temperature to be 100 F and the cold water temperature to be 80 F.

This indicates that the possibility of a lower cold water temperature obtained by the lower existing wet bulb temperature was lost, because of the adverse effect of the increased water quantity.

Fig. 6 shows the type of performance curve furnished by the cooling tower manufacturer. This shows the variation in performance with change in wet bulb and hot water temperature, while maintaining the water quantity constant.

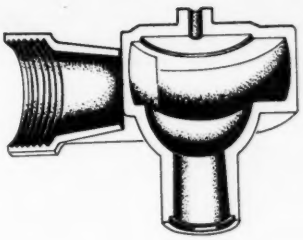


Fig. 6—right. Typical performance curve for a mechanical draft cooling tower

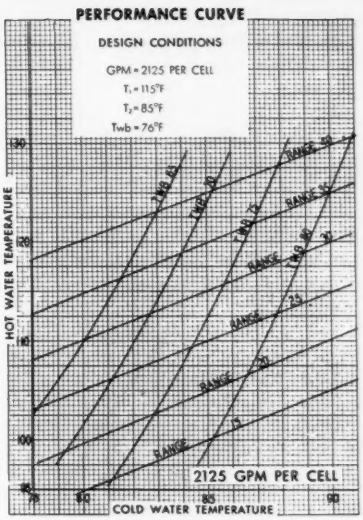


Fig. 7—above. Cut-away view of upspray nozzle, with side entrance to start spiral action upward to discharge orifice. Removable screw plate can be drilled for automatic draining to prevent winter freezing

Cooling Tower Spray Nozzles

Type of nozzles used in upspray cooling tower distributing systems is shown in Fig. 7. The accompanying table gives the performance of a particular family of nozzles. In upspray distributing systems, a pressure of 7 psi is common practice; however, 5 psi is adequate.

This nozzle is designed to be of the non-clogging type, to depend for minimum drop-size upon centrifugal force. The water is given a spiral action by its tangential entrance into the spiral chamber. The dome-shaped approach to the discharge orifice is built to increase this spiral action as it approaches the discharge orifice. This whirling action is intended to generate the necessary velocity for fine breakup and to assure uniform drop-size and efficient water distribution over a maximum area. Such a formation of uniformly small drops assures maximum contact with air, resulting in high cooling efficiency.

Details of the methods for evaluating performance of atmospheric cooling towers will be given in a subsequent article.

Table showing capacities of spray nozzles illustrated in Fig. 7

Nozzle Number	Pipe Size	Orifice Size	PRESSURE IN POUNDS PER SQUARE INCH 5	6	7	8	9	10	12	15	20	25	30
			CAPACITY IN U. S. GALLONS PER MINUTE										
2.4	3/8"	3/16"	. .	. .	1.0	1.1	1.2	1.3	1.4	1.6	1.8	2.0	2.2
2.4	3/8"	5/16"	1.8	1.9	2.1	2.2	2.3	2.3	2.7	3.0	3.4	3.8	4.2
7	1"	7/16"	6.5	7.1	7.7	8.2	8.7	9.2	10.1	11.3	13.1	14.6	16.0
14	1"	5/8"	11.5	12.6	13.6	14.5	15.4	16.2	17.7	19.8	22.7	25.3	27.8
19	1 1/2"	7/8"	16.8	18.3	19.8	21.1	22.4	23.5	25.8	28.7	32.9	36.5	40.0
24	1 1/2"	1"	20.0	22.0	23.8	25.3	26.9	28.3	31.0	34.7	40.0	44.8	49.0
39	2"	1 1/4"	33.0	36.2	39.0	41.8	44.3	46.7	51.0	57.0	65.8	73.3	80.0
49	2 1/2"	1 25/32"	39.5	43.0	46.5	49.5	52.5	55.0	60.5	67.0	78.0	86.0	94.0

CAPACITORS

(*Continued from page 103*)

will cover the usual range of the standard synchronous condensers.

DIRECTLY CONNECTED CAPACITORS AND REACTORS

The tap changing transformer equipment adds considerable expense to an installation. If the repetitive switching duty can be handled satisfactorily by a breaker and there are not a great number of switching steps required, then directly connected capacitors and reactors as shown in Fig. 6 are less costly than the schemes involving the tap changing transformer.

CAPACITOR AND SYNCHRONOUS CONDENSER COMBINATION

A synchronous condenser lends itself well to control of kvars where a large range of leading to lagging is required. It also provides a means of improving system stability or smoothing out voltage dip where these features are desired. Capacitors on the other hand are less expensive, easy to install, lower in losses, and are easily added to or subtracted from.

The combined advantages of the two types of equipment have been realized by adding capacitors to an existing synchronous generator installation. The capacitor may be used primarily as a base correction with the synchronous condenser output varying to meet the variations of kvar requirements with changing load conditions. The diagram shown in Fig. 5-B illustrates the combination of synchronous condenser and capacitor.

LEAVE IT to an engineer to apply his knowledge to making tasks at home easier to do. One ingenious engineer has cut down large trees on his lawn by burning through the trunk with an electrically heated piece of Nichrome resistance wire. A transformer was used to obtain high current at low voltage, and the hot wire was pulled through by weights.

Placing the Steam Generator in Operation—II

By **JOHN C. GORE**, Power Engineer, General Foods Corp., Post Cereal Division

THE FOLLOWING MORNING the service engineer returns to the plant at an early hour and after changing clothes he immediately goes to the boiler operating panel. He receives the report that the primary air fan bearing is still running hot even though the oil has been changed in the bearing several times during the night in an effort to cool it down. He has the operator change pulverizers thus removing the offending primary air fan from service and the erection crews find a job waiting for them on their arrival at the plant. The bearing cap must be lifted as the bearing is to be inspected for evidence of dirt or other foreign substances. Several hours are spent in this work and the bearing is found to be rough and the Babbitt metal has run slightly in one spot from excessive heat. The bearing is otherwise undamaged and the rough spot is removed by scraping and the bearing is refitted for proper clearance. The lubricating system is flushed clean using kerosene followed by light lubricating oil. Some evidence of contamination or dirt is found in the oil removed but the original source of such dirt is hard to determine as it may have been insulation or other material which has collected in the bearing during the erection period. After cleaning, the bearing is assembled and new oil is added to the case. The pulverizer is placed in service a short time later and the service engineer now finds that the bearing runs smoothly without overheating.

The load on the boiler unit is increased during the morning hours and the service engineer finds that two pulverizers will give approximately 90 per cent of the rated steam flow for which the boiler unit was designed. As the rating is increased it is evident that the temperatures of the superheated steam leaving the unit are low and the service engineer instructs the operating crews not to use the furnace wall blowers until further notice. The superheater bypass damper is closed and as the furnace becomes dirty and the walls slag up the steam temperature will increase until it reaches the 900 F temperature for which the unit was designed after which the bypass damper can be opened for steam temperature control. It is also noticed that burner adjustments have some effect on steam temperatures and that as the work of sealing off air leakage progresses, the steam temperature increases due to higher mass flow of air through the furnace and across the superheater elements.

By the end of the first week operating procedures are becoming routine to the operating crews. Operation has been uneventful and the weary operating crews find their duties becoming monotonous. The tense expectancy of the starting-up day has passed and the service engineer uses every moment available to instruct the operators in an attempt to hold their interest. During the second week of operation the service engineer is spending an idle moment one day sitting on a box of insulation, talking to one of the erectors. The service engineer has been congratulating himself for several days on the assumption that a difficult and hard job has been so easily accomplished. The combustion controls are now in service and the meters and instruments on the operating panel have all been calibrated. The service engineer is relaxed and feels satisfied that he will have very little future trouble on this job.

TO REDUCE EXPLOSION HAZARDS AFTER LOSS OF IGNITION WHEN FIRING PULVERIZED COAL, GAS, OIL OR OTHER SUSPENDED FUEL IN A BOILER UNIT

CONDITION OF AIR FLOW ON LOSS OF IGNITION	CHANGES TO AIR FLOW	PURGING PERIOD	
		Length	Air-Flow Rate
Over 25 per cent of maximum rated air-flow as shown by steam, air-flow pen or draft gages	Reduce slowly to 25 per cent of maximum rated air flow	5 minutes	25 per cent
At 25 per cent of maximum rated air-flow as shown by steam, air-flow pen or draft gages	Do not change	5 minutes	25 per cent
Below 25 per cent of maximum rated air-flow as shown by steam, air-flow pen or draft gages	Do not change Do not increase	Variable See Fig. 3 Below	Hold at same rate of air flow as that existing when ignition was lost

Trouble

Suddenly the lights flicker and the service engineer glances up in surprise. The erector is left seated alone on the insulation box and he watches in wide mouthed surprise as the service engineer makes a mad dash for the operating panel. The familiar sounds of the operation have changed and a new note of warning is heard all through the plant. The hum of fans and the roar of the pulverizers has changed to a dying wail and red warning lights indicating the loss of electric power to all motors are flashing onto the operating board. The shrill waring bells and the raucous sound of the alarm horns notify everyone

This is the second installment of Mr. Gore's description of what takes place during the first few days and weeks of operation of a large steam generator. In the May issue, he described the action during the first full day of operation. Now, in this installment he takes the reader through the following six weeks when the service engineer's work is finally complete and he bids the operators good-by. In this article Mr. Gore gives considerable attention to the care and operation of pulverizers—how to clean them, how to combat fires in pulverizers, etc. He also describes the first outage

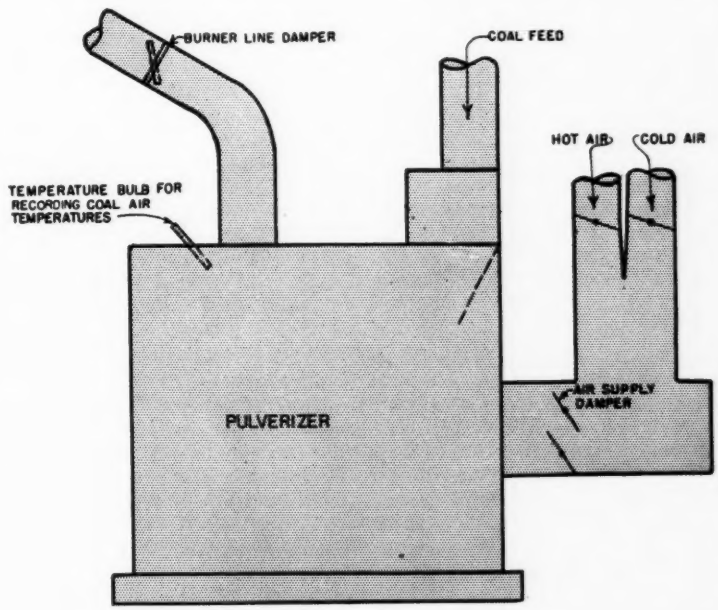
present that the plant is going down. The startled operator still half dazed finds the service engineer in front of him stopping coal feeders and pushing stop buttons shutting the pulverizers down.

The service engineer quickly glances at the air flow pen and notes that it is still above 50 per cent of full rating. The draft gages indicate some air flow through the unit and the service engineer has every reason to believe that the induced draft fan is still turning but is rapidly slowing down. On a vague hope or impulse, he pushes the starting button for this fan and is surprised as the fan starts up with a low whine and begins to pick up speed. The service engineer quickly throws the induced draft damper controller on to remote-manual and holds the air flow through the unit to the 40 per cent of maximum showing on the steam-air flow meter. He closes the induced draft damper slowly so as to restrict the air flow through the unit as the fan picks up speed and when the fan finally reaches full speed the air flow is still at 40 per cent of maximum. He continues to slowly lower the air flow by closing the induced draft damper until it reaches 25 per cent of maximum. He keeps glancing at the burner ports but they remain dark and he heaves a sigh of relief as he realizes that no coal dust is present to ignite and cause an explosion in the hot glowing furnace. The operator is placing all controls on remote-manual and the service engineer is thankful for his quick intelligent asisstance.

After establishing the air flow at 25 per cent of maximum the service engineer goes to the burner port holes and peers into the furnace. A faint red glow from the hot slag is visible but no flame exists and the furnace seems to be clear and free of coal dust. He then turns back to the operating panel and makes a quick inspection for any electrical switches which he may have left in the on position in his hurry to make sure that all fuel to the furnace was stopped. The water alarm whistles are shrill in their warning that the water level in the top drum is low and that the feed pumps are not in operation. Confusion seems to reign before the panel board as excited plant officials, erectors and even sleepy Joe gather in front of the panel with a thousand questions on their lips.

The operator coolly asks these men to avoid crowding in front of the operating panel and ignores many of the questions they fling at him. To their queries as to what has happened, the answer is always the same, "I don't know." Suddenly the high pitched whine of a motor starting is heard from the lower floor and the service engineer turns in time to see the operator locking in the starting switch on No. 2 feed pump. Again he is thankful for this man's calm acceptance of the problems of the moment and both he and the operator now realize that power is available for starting up the boiler auxiliaries.

One of the plant officials reduced to the unexpected status of a messenger boy by the emergency, brings word to the boiler operating panel that the turbine is still on the line but carrying a reduced electrical load. The boiler operator shouts back information to the effect that if load is reduced to a minimum he believes that he can restore the boiler unit to normal service in the next 10 to 15 minutes without dropping the generator off the line. He then tells the service engineer that the boiler purging process with air flow at 25 per cent of maximum has been maintained for a period of 3 minutes. The service engineer nods his head in appreciation for this man's quick thinking in securing the time that the induced draft fan was



Control of Fire in Pulverizers

A—When Pulverizer is Not in Operation

1. Close air supply and burner line dampers. Make sure all air is sealed off from entrance to mill. Coalfeeder pipe should be full of coal to eliminate air.
2. Flood pulverizer interior with steam or carbon dioxide.
3. Open after 20 or 30 minutes. Watch for fire or possible explosions when opening.
4. Use fire extinquisher or water hose to put out remainder of fire.
5. Clean coal out of pulverizer manually.
6. If water was used place pulverizer in service or dry out with hot air.

B—When Pulverizer is in Operation

1. Hold and stabilize air flow being maintained when fire is discovered. Do not increase air flow. Use manual control do not leave on automatic.
2. Increase coal feed to pulverizer.
3. Close hot air damper open cold air damper.
4. Run pulverizer until temperature drops to normal then restore normal operation.
5. If temperature does not drop increase coal feed until pulverizer is overloaded and stops or stop pulverizer manually. Do not attempt to clean pulverizer by burning out coal in burner.
6. Proceed as outlined above in 1 after pulverizer is out of service.

LENGTH OF PURGE PERIOD AFTER LOSS OF IGNITION WHEN AIR FLOW WAS LESS THAN 25 PER CENT OF MAXIMUM RATED AIR FLOW	
PERCENT OF RATED AIR FLOW AS SHOWN BY STEAM, AIR-FLOW METER	LENGTH OF PURGE PERIOD MINUTES
25	5
20	10
15	15
10	20
5	25
0	30
Never under any circumstances increase the air flow through the boiler unit until the purge period is completed as indicated above	

returned to service, and indicates with two fingers that the purge period will require another 2 minutes for completion. The operator manipulates the induced draft damper to maintain 25 per cent air flow while the service engineer and the boiler helper close off the forced draft damper, the burner windbox dampers, the primary air dampers and the coal-air dampers in the burner supply piping. The operator starts the forced draft fan and the whine of the motor coming up to speed replaces the shrill alarm of the low water whistles which finally die away indicating that the top drum water level is now normal. The operator has been watching the pressure gage and notes that the steam pressure is down to approximately 50 per cent of the designed operating pressure. He seems to be waiting for something, as he stands watching the meters and gages and to the waiting plant officials, his delay is annoying as they are wondering if the turbine can be held on the line.

The warning lights on the purge flow interlocks now flash white indicating that the 5 minute purge period is complete. The operator immediately swings into action and the service engineer stands back to watch. The operator adjusts the forced draft damper to give the desired windbox pressure. The helper has an oil torch in place and it is lit off and the burner damper is opened a slight amount to provide air for combustion. The operator starts the pulverizer and hesitates for a moment as the mill makes a slow rumbling noise indicating that it is still full of coal. He watches the electrical ammeter which shows a motor overload and he wonders if the overload relays will hold until the pulverizer reaches full speed. As the ammeter pointer finally swings back into normal operating position he turns and signals his helper to open the valve in the burner line. As coal ignites smoothly in the burner he quickly reaches over and turns on the coal feeder. He then adjusts the induced and forced draft dampers while the helper opens the burner damper an amount predetermined by previous operation which gives a bright clear flame. The operator opens the primary air damper increasing the air-coal flow to the burner and is constantly adjusting his induced and forced draft dampers to give additional air flow for combustion. The helper now has a second oil lighter in place and as the operator signals, he brings the second burner into service and ignition is instantaneous and stable. The operator rapidly increases air-flow and fuel to the burners and in less than a minute has the first pulverizer firing at maximum rating.

With the pulverizer now up to full rated load the operator watches the steam pressure recorder for the first indications of a rise in pressure. The downward trend of the pressure pen hesitates, levels off and then slowly starts to swing upward. The operator who has watched the pressure drop so quickly a few minutes before, is pleased to know that the turning point has been reached. He notices that the steam flow is very high due to the inaccuracy of the flow meter at low pressures. He checks the load on the kilowatt meter and determines that the turbine generator is carrying about 25 per cent of maximum load and this indicates that the one pulverizer should be sufficient to hold the load and to increase the steam pressure.

The operator watches as the steam pressure slowly creeps upward and finally decides that a second pulverizer will not be needed. This decision is barely formulated when a telephone call from the load dispatcher informs him that the turbine engineer is waiting to pick up load. With a resigned shrug he merely reports that the boiler is back in service and turns to his helper and indicates that the third burner and second pulverizer is to be placed in service. The second pulverizer is quickly placed in service and the firing rate increased to the maximum. The turbine load however is also increased to approximately 80 per cent of maximum and the steam pressure although it continues to increase does so very slowly.

Another telephone call from the load dispatcher informs the operator that the load will be held constant until the electrical crews complete some checking which they are now doing. The operator takes time to ask the load dispatcher what has caused the interruption and the load dispatcher reports that some trouble has been experienced in the use of the new electrical switchgear in the substation of the new plant. Electrical service has been restored by bringing in the emergency tie circuits and the electrical crews are now trying to clear the fault.

The operator passes the message along to the men waiting at the operating panel that the load has been stabilized and that the interruption was due to a fault in the electrical switchgear in the substation. Several plant officials leave immediately for the substation and the crowd at the panel slowely disperses. It is now about 20 minutes since the interruption to normal service has occurred and in another 10 minutes the steam pressure is back to normal. The operator places the controls on automatic and operation quickly smooths out and is trouble-free.

Cleaning Out Hot Pulverizers

The service engineer and the operator's helper are down cleaning out the third pulverizer which was shut down while full of coal. They find this rather difficult as this pulverizer was stalled while full of coal and it cannot be started with the motor. They open the doors and find the coal has jammed the rotating parts of the machine. By using their hands they manage to scrape enough coal from the pulverizer so that it can finally be started using the motor and it is then relatively an easy matter to finish the cleaning operations as the machine throws the remaining coal into the pyrities trap and it can then be shoveled out without difficulty. The service engineer explains to the helper that it is important to clean a hot pulverizer which has been stalled full of coal because of the danger of smoldering fires in the hot equipment if the coal is allowed to remain for over 30 or 40 minutes. If the pulverizer cannot be returned to service the coal should be cleaned from it as soon as possible and care should be used when opening the doors on the machine as a fire may be present which will cause a dust explosion.

After cleaning the pulverizer the service engineer goes back to the operating panel and soon he and the operator have their heads together discussing the recent outage. The operator is now intensely interested and his questions cover every phase of the procedures followed during the outage. The first operation of stopping the pulverizers

and coal feeders is quickly explained as the importance of stopping fuel feed to the furnace is apparent. The explosion dangers, which would occur if a cloud of combustible coal dust were to be blown into the hot furnace after burner ignition is lost, are eliminated by immediately shutting down the pulverizers. In no instance should the pulverizers be started until a light-off torch is in place in the burner as the coal dust which would be blown into the furnace is likely to be ignited from a hot piece of slag causing a very serious furnace explosion.

The second procedure of stabilizing the air flow is for the purpose of eliminating excessive amounts of oxygen or air to the furnace as this is a controlling factor in an explosion of any fuel which might be present. Explosive mixtures of air and coal are likely to occur if the air flow is increased. The air flow should never be increased when ignition is lost unless the boiler setting is filled with steam due to the failure of a pressure part. The service engineer carefully outlines the procedure to be followed in case of loss of ignition from any reason except when the setting is full of steam as mentioned above. If the air flow is over 25 per cent at maximum on loss of ignition, do not under any circumstances increase the air flow but slowly decrease it by closing the forced and induced draft dampers until the air flow is reduced to 25 per cent of maximum. The 25 per cent of maximum air flow thus established is to be maintained for a 5-minute period to purge or sweep the setting of all explosive gases or pulverized coal mixture before any flame is to be placed in the unit. If air flow is at the required 25 per cent of maximum specified above when the loss of ignition occurs then this air flow should be maintained until the 5-minute purge period is complete. If however, the air flow through the unit is below the 25 per cent of maximum specified above, then the following procedure is to be followed. Maintain the air flow at the rating at which the loss of ignition occurred. Do not under any circumstances increase the air flow. When the air flow is below the 25 per cent of maximum the length of the purge period should be progressively increased as the rate of air flow becomes less. A purge period of 25 minutes is necessary when the air flow before loss of ignition is 5 per cent or less of maximum air flow.

The operator also asks about the proper procedure to be followed in case of a fire in a pulverizer. The service engineer quickly repeats his former instructions on cleaning a pulverizer if it is stalled full of coal and is not to be returned to service and states that a fire should not occur in an idle pulverizer. The operator is not satisfied with this answer and wants to know what procedure is to be followed if a stalled pulverizer is known to have a fire in it. The service engineer states that several things can be done to control and to put out such a fire. The pulverizer should not be started under any circumstances. All the dampers in the air supply lines to the pulverizer and all the valves in the burner lines should be closed in order to cut off any possible air supply to the fire. Carbon dioxide if available, or steam, can be used to flood the pulverizer and thus smother the fire. A connection will be found on most pulverizers which is suitable for fastening a steam hose to so that the interior can be flooded with steam. If such a connection is not available one can easily be provided when the pulverizer is out of service or before starting up this equipment.

After smothering out the fire in a pulverizer it should be opened and cleaned. When the pulverizer has been idle for 20 to 30 minutes and when the temperature recorder indicates that the fire is dying out or is smoldering quietly, the pulverizer should be opened. The doors should be opened carefully and the men doing this work should avoid placing their bodies in line with any swinging door or door opening in order to eliminate the danger of an injury occurring in case of an explosion. After the door is opened the pulverizer can be flooded with water or a fire extinguisher can be used to extinguish any remaining evidences of the fire. The coal can be removed manually without wetting it down if care is taken to avoid stirring up piles of smoldering coal dust. This last method is not recommended as it does involve some hazards to the men who may have to enter the pulverizer to remove the smoldering coal. If water is used, the pulverizer should be placed in service immediately after cleaning in order to dry out the interior and to avoid excessive corrosion or rusting of the metal parts.

The operator is still not satisfied with the information he has secured from the service engineer on pulverizer fires and continues to ask questions. He wishes to know if fires are likely to occur in pulverizers in operation. The service engineer tells him that such fires are not a common occurrence but that they do occur especially if the temperatures of the coal-air mixture leaving the pulverizer are allowed to exceed 180 or 190 F. If such a fire occurs the coal-air temperatures will increase rapidly to values in excess of 250 F. When the coal feed and the temperatures of the air to the pulverizer are normal and such a high pulverizer outlet temperature suddenly ocurs it is a good indication that a fire is present in the pulverizer.

The proper procedure to be followed if a fire is suspected in a pulverizer in operation, is as follows: Place the primary air damper controller on manual so as to maintain the constant air flow. Be sure that the air flow through the pulverizer is not increased. Increase the coal feed to the pulverizer so as to give a rich coal-air mixture which will avoid the explosive mixture likely to occur with an excessive amount of air. Close the hot air supply damper and open up the cold air damper the amount required to replace the hot air which has been shut off. Continue the pulverizer in operation for 15 or 20 minutes and watch the coal-air temperature recorder. If a drop in temperature occurs this will indicate that the fire has gone out and the pulverizer can be restored to normal operation. However if the temperature does not drop within 15 or 20 minute the coal feed should be increased until the pulverizer is overloaded. The primary air damper should be quickly closed and the pulverizer should then be quickly stopped while still full of coal. The burner line valves and the cold air and hot air dampers should be closed to cut off all possible air sources to the idle pulverizer. The procedure for handling fires in pulverizers out of service as outlined above should then be followed. Do not under any circumstances try to clean a pulverizer out by blowing the coal to the burner if a fire in the equipment is suspected.

The operator finally has to discontinue his questions as the load dispatcher requests more load and the third pulverizer has to be placed in serv-

(*Continued on page 138*)

EMERGENCY PROCEDURES TO BE FOLLOWED AFTER ACCIDENTAL LOSS OF IGNITION WHEN FIRING PULVERIZED COAL, OIL OR GAS

1. **Stop all fuel to furnace. Shut off pulverizers and feeders**
2. **Stabilize air flow and place damper controls on manual**
3. **Establish air flow required for purging setting of all explosive gases or fuel. (See Fig. 2 and 3)**
4. **Make sure of feedwater supply and keep water in boiler**
5. **Close all dampers but those required to assure air flow for purging setting**
6. **Make sure that all electrical switches are in proper position to avoid accidental starting up of equipment**
7. **When purge period is complete insert oil lighter in burner and light this burner. Make sure that pulverized coal or other fuel does not enter any burner except the one in which a light-off is present**
8. **Light off additional burners as required to hold load**
9. **When steam pressure reaches its normal value place all controls on automatic and restore normal operating conditions**

ATOMICS

A New Section added to POWER PLANT ENGINEERING to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

What Price Nuclear Power ?

Continued delay in effecting international control of atomic energy is serious . . . Foreign nations are busy with atomic developments . . . How much help did the Smyth Report give other nations? . . . It is later than most people think . . . Effect of short wave radiation on living things . . . Dangers from nuclear power development

By ANDREW W. KRAMER Managing Editor, Power Plant Engineering

ALMOST TWO YEARS have passed since the first atomic bomb was exploded over the city of Hiroshima. In that interval, the horror of what happened there and at Nagasaki a few days later has been told and retold in millions and millions of printed and spoken words as well as in pictures and diagrams. No effort has been spared in emphasizing the terrible destructiveness of that atomic bomb. At the same time a million repetitions and demonstrations of proof have been made by responsible persons that the secret of the atomic bomb cannot be maintained over a course of years and that there is no defense against this type of weapon except international control of atomic energy. Scientists everywhere have pointed out that an atomic armament race can only lead to the complete destruction of civilization as we know it.

Despite all this effort, it seems to have failed in impressing people with the terrible seriousness of this problem of atomic energy. After almost two years practically no constructive action has been taken and the United Nations Security Council has been engaged in endless argument and bickering about the subject. Even here, in our own Congress, the appointment of members of the Atomic Energy Commission has been sabotaged by the clownings of Senator McKellar and his cronies.

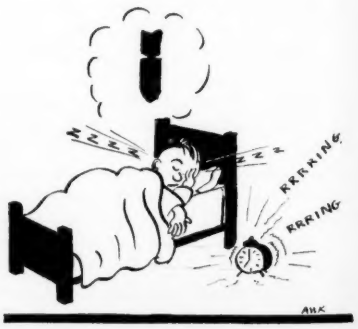
Whatever reason may be advanced for the delays and lack of action on the part of those whose business and duty it is to settle these matters, the real reason is that these people themselves do not realize the awful implications of the thing they are dealing with. If they did, they would have been able to reach an agreement in a few days. Many of the statesmen think, and conclude that their constituents think, that our defense against this enigmatic and, hence, frightening subject is to withdraw into a womb—we must keep the secret of the atomic bomb to ourselves. The logical conclusion of this conception calls for a ban on international co-operation and a clutching of the precious secret to the bosom.

Foreign Nations Are Busy

It seems to be difficult for non-scientific people to realize that scientists of other nations also knew something about nuclear physics, that even now concentrated research in this field is going on in all the major countries of the world and in many small ones as well. Large government sponsored programs of atomic research and development are going on in Canada, Great Britain, France, Russia and Argentina and smaller scale programs are in progress in Denmark, Sweden, Norway, Switzerland, the Netherlands and New Zealand.

Consider, for example, the French program. There, a Commissariat for Atomic Energy has been established under Frederic Joliot-Curie with extensive powers. It was launched over a year ago with 500,000,000 francs at its disposal. An "atomic village" of 2000 inhabitants working in laboratories with experimental piles, is to be built outside of Paris, and there is also to be a large plant at a provisional site.

Of course when atomic energy is considered these days everybody thinks of Russia—we are suspicious of Russia. Little information has been made public about atomic developments in Russia but it is generally known that considerable work is being done. It would be only natural that the Russians would



It is late — later than you think

engage in large scale nuclear research and development. The Academy of Sciences in Russia has its own 5-year plan, and it no longer plans its work only one year ahead. Its president reported that 10,000 men and women are engaged in scientific work. Numerous scientific papers in the past have indicated Russian knowledge of nuclear physics. In 1942, A. E. Brodsky separated U-235 by thermal diffusion at the Dnieperpetrovsk power plant but concluded that the power consumed in the process rendered this method impractical.

The only reason for mentioning these foreign developments here is to emphasize once again the fact that we cannot possibly hope to keep the atomic bomb to ourselves. No reputable scientist ever thought so. While the atomic bomb came as a complete surprise to the people of the world at large, it was not too startling to people who had been paying attention to what was going on in physics. The theoretical possibilities became apparent with the revolution in physics early in the century. All through the thirties, as one energy releasing

Suppose you had a lump of uranium 235 in each hand

transmutation after another was demonstrated in the laboratory, it was evident that we were on the edge of a basic discovery. Remember also that the basic scientific facts from which the atomic bomb was developed were largely the discoveries of European scientists; nuclear fission by Hahn, Meitner and Strassmann of Germany; transformation of uranium by neutrons, by Fermi of Italy; theory of fission by Bohr of Denmark and Wheeler in the United States; the neutron, by Chadwick of England; artificial radioactivity, by Joliot and I. Curie of France. Speculation concerning the possibility of a fission chain reaction and of the fission bomb was world-wide in 1939, and much of the theory of the phenomena involved was published. What could not be known with certainty was whether the exact properties of the nuclei concerned would permit a chain reaction and make a bomb practical. This was completely answered by the newspaper stories on August 6, 1945, revealing that an atomic bomb had indeed exploded. Whatever secret we had, we gave to the world on that day.

[1] Atomic Energy for Military Purposes, by H. D. Smyth.

There has been criticism regarding the release, by the Army, of the Smyth report.[1] True, the Smyth report describes in some detail the many possible modes of attack on the problem of producing atomic explosives and indicates which of these have been successfully pushed to completion on a mass production scale. Most of the significant numerical values for the nuclear properties are omitted, but the experiments by which they are measured are described. This report places information in the hands of the scientists at least equivalent to what was known in this country towards the end of 1942. It has been estimated that the remaining knowledge—a mass of scientific, engineering and technical detail—if completely released, would save any interested group of scientists only six months to a year in their effort to produce bombs.

These are facts; they can be verified by talking to any group of reputable scientists. Other nations will have no particular trouble in making atomic bombs in a matter of a few years, whether it is two, five or seven years does not make much difference, from a technical standpoint. What does make a difference, however, is how soon the statesmen and politicians will act to put a stop to the making of all atomic bombs everywhere, here as well as in other countries.

It is Late — Later than you think

It is far later than most people think. With every tick of the clock we are moving more closely toward world destruction unless we bring atomic energy under international control. There is no other way and if the politicians in whose hands the matter lies could only see that, they would come to an agreement in five minutes. The issue is simply this; international control or complete destruction. Dr. Robert Oppenheimer who had charge of the design of the atomic bomb at the Los Alamos Laboratory, has estimated that 40,000,000 Americans might be killed in one atomic attack.

Estimates such as Dr. Oppenheimer's and similar predictions have not been kept secret. They have been published and told and retold in millions of words and people have read them. They may talk about them and assure one another that they are true, yet, way down, deep in their hearts they cannot believe that such things really could happen. The trouble, lies in the fact that they do not understand the difference between nuclear energy and the energy of chemical reactions such as exemplified by the explosion of TNT or dynamite. There is an enormous difference.

Suppose you have in your hand a stick of dynamite. With a percussion cap you can set it off. Now break the stick in half; you can still explode it, in fact you can break off a very little piece of the dynamite and it will explode. You can do the same with TNT or with ordinary black powder. The same thing is true of any ordinary fuel

You decide to bring your arms together

such as wood, coal oil or gas; no matter how small the sample, once the temperature is raised to the kindling point, it burns.

Now, suppose you have in your hand a lump of uranium 235, say, a mass the size of a billiard ball. It will be very heavy but otherwise it will exhibit no unusual properties to the eye nor to the touch. Of course, if you held it near a box of photographic film you would find that in time the film would be fogged; it is very slightly radioactive, millions of times less radioactive than is radium. You could do anything you wanted to this small lump of U-235 without harm or danger. You could heat it to the highest temperatures without harm; you could hit it with a sledge hammer; you could blow it sky high with a dynamite or TNT explosion but you would find the uranium to be unchanged after the explosion, assuming that you could find the pieces. In short, you would find the uranium almost completely inert. The same thing would be true if the mass of uranium was the size of a small grapefruit.

Let us assume, however, that you had two such masses of U-235, one in each hand, each mass the size of a small grapefruit. You would have to be strong to hold them for they would be heavy but if you could hold them you would find that nothing unusual happened. Each of the two masses would be quite harmless no matter what you might do to it.

So far all is well. Suddenly, however, you decide to knock these two lumps of U-235 together, as hard as you possibly can. You bring your arms together! That would be the last thing you would ever remember. The resulting explosion would be very weak, more or less of a dud, because of your inability to bring the two masses of uranium together fast enough. The initial release of nuclear energy as the two masses came together would blow the masses apart before the chain reaction extended to any large number of atoms and the reaction would stop. The trick in the atomic bomb is to bring the two masses together so fast that the reaction extends to practically all of the atoms in

Table showing the half-life value of some of the more common radioactive isotopes. (Data taken from G. Seaborg, Rev. mod Physics 16, 1, 1944)

Element	*Atomic weight of the isotope mixture occurring in nature*	*Symbol of the radioactive isotope*	*Half-value time*
Hydrogen	1.0081	$_1H^3$	31 years
Carbon	12.010	$_6C^{11}$	20.5 minutes
		$_6C^{14}$	>1000 years
Nitrogen	14.008	$_7N^{13}$	9.93 minutes
Oxygen	16.000	$_8O^{15}$	2.1 minutes
Sodium	22.997	$_{11}Na^{22}$	3.0 years
		$_{11}Na^{24}$	14.8 hours
Magnesium	24.32	$_{12}Mg^{27}$	10.2 minutes
Phosphorus	30.98	$_{15}P^{32}$	14.3 days
Sulphur	32.06	$_{16}S^{35}$	87.1 days
Chlorine	35.457	$_{17}C^{38}$	37 minutes
Potassium	39.096	$_{19}K^{42}$	12.4 hours
Calcium	40.08	$_{20}C^{45}$	180 days
Manganese	54.93	$_{25}M^{52}$	6.5 days
Iron	55.84	$_{26}Fe^{59}$	47 days
Copper	63.57	$_{29}Cu^{64}$	12.8 hours
Bromine	79.916	$_{35}Br^{82}$	34 hours
Strontium	87.63	$_{38}Sr^{89}$	55 days
Iodine	126.92	$_{53}I^{126}$	13 days
		$_{53}I^{128}$	25 minutes

the resulting mass before the force of the explosion can blow them apart. It has to be done very fast, probably by the use of a TNT explosion as an accelerating force.

Assuming that the two masses are brought together fast enough, the resulting explosion will be many millions of times more powerful than if a similar mass of TNT were exploded. No information has ever been released regarding the actual amount of fissionable material used in the atomic bomb but a reasonable guess is that it is somewhere around 40 kilograms, about 88 lb. This 88 lb of U-235 therefore provided an explosion equal to that of some 20,000 TONS of TNT! As has been indicated in previous articles in this section, however, the comparison of the bomb explosion with that of 20,000 tons of TNT is inadequate unless temperature and radiation effects are also considered. With the bomb, temperatures of millions of degrees are obtained whereas with TNT the temperature of the explosive reaction is only a matter of a few thousand degrees. Furthermore, in the case of the atomic bomb, there is tremendous radiation of gamma rays, beta rays and neutrons at the instant of the explosion followed by the lingering radioactivity of the fission products and the radioactivity induced in surrounding material by the neutron bombardment.

Effect of Short Wave Radiation on Living Things

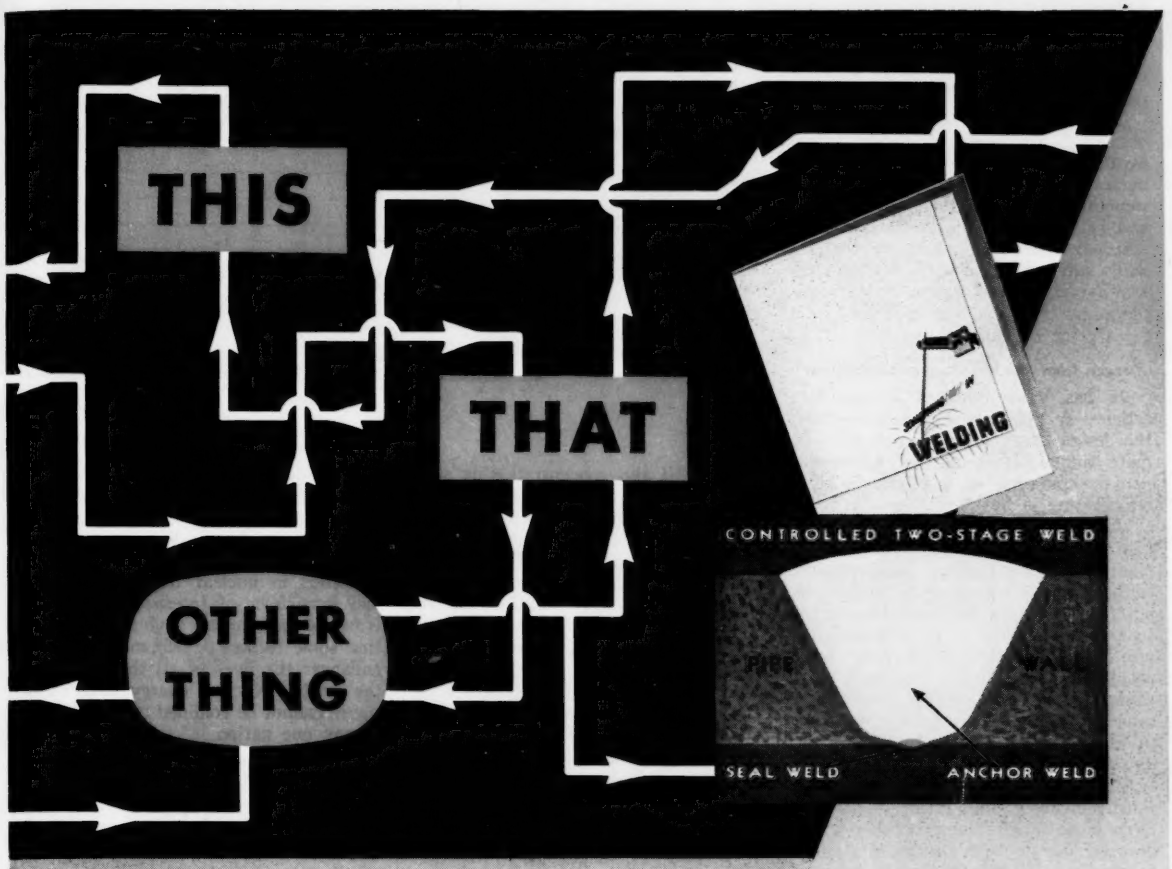
The radioactive effects of the atomic bomb are the effects most to be feared because they are insidious; their delayed action is demoralizing and terrible. Since the atomic bombs were exploded at Hiroshima and Nagasaki, many of us are familiar with the type of burns and destruction of organic cells due to the instantaneous radiation from the blast. What is not generally known, however, is how this radiation may affect future generations of the survivors of these two cities. For it is well-known now that x-rays and gamma rays affect the reproductive cells and that cells so irradiated result in profound hereditary changes. Many years ago, it was discovered that all sorts of hereditary changes could be caused in the offspring of fruit flies by exposing the flies to x-rays. Recently the Nobel Prize was awarded to an American geneticist, Professor Hermann J. Muller, for his work in this field at the University of Texas. By exposing the flies to x-rays he induced tremendous speed-up in the rate of hereditary change in these flies. For every change that had appeared under normal conditions, the x-rays brought forth 150! He produced all sorts of freaks; flies with different colored eyes, flies with stub wings or with no wings at all, flies with every kind of hair form, dwarf flies, lopsided flies. These changes were startling enough but when the flies were bred together, he got flies that no longer even looked like flies.

These facts are old; they were described years ago—long before the atomic bomb. They are of interest now, however, because it is possible that the large scale release of highly radioactive isotopes, not only from atomic bomb blasts but from nuclear reactors used for power generation, may cause similar hereditary changes in members of the human race as well as other animals. There was a rumor, I can't vouch for its authenticity, that cattle, some 50 or 100 miles from the plutonium plant at Hanford, Washington, showed traces of radioactivity.

ATOMICS

Perhaps some of the hair raising predictions made in popular articles in the general magazines and newspapers are without adequate scientific foundation, yet the fact remains that the potential danger in the release of large amounts of radioactive material is serious. It is dangerous to upset the balance of nature. Through the centuries, all living things on the face of the earth have been fitted for their environment. They have developed so that they are able to live and survive under certain conditions of temperature, humidity, radiation from the sun and outer space, etc. Nature has arranged it so that we are protected from the extremely harmful radiation coming from the sun, the very penetrating x-rays, harmful ultraviolet rays and streams of electrons emanating from the surface of the sun. It is known that at a height of somewhere around 60,000 feet the very short ultraviolet rays from the sun, form a layer of ozone, which is opaque to wavelengths shorter than 3000 Angstroms. Thus, this layer of ozone prevents any rays shorter than 2900 Angstroms reaching the earth's surface, with a profound effect on the development of plant and animal life on the earth. True, the extremely highly penetrating cosmic radiation gets through the atmosphere to the surface of the earth but life, somehow, through countless generations has been able to adapt itself to the incidence of this cosmic radiation, in fact modern genetic theory makes use of cosmic radiation in accounting for mutation, that is, the hereditary changes which takes place in the evolution of living things. The most individual characteristic of life is that in no case is the offspring exactly the same as the parent; there is always some slight change. This slow change accounts for the evolution of all species of living things, plants and animals alike. True, various internal or local external influences might be sufficient to account for these mutations but since it has become known that x-rays are able to affect the hereditary factors—the genes—it is quite possible that the normal hereditary changes in living things throughout the centuries is caused by cosmic rays. Whether this is true or not, it is well established that x-rays do bring about startling hereditary changes in fruit flies and since the mechanism of evolution is essentially the same in all living things it is reasonable to suppose that such radiation can cause similar hereditary changes in human beings. It is definitely known that x-rays cause sterility in human beings.

From preliminary reports by navy scientists, fruit flies placed on the ships of the target array at the Bikini tests last summer have now been bred for several generations and descendants show many of the mutated freak forms previously obtained in the laboratory with x-ray radiation. Admiral Blandy, chief of the Bikini operations pointed out recently that navy men who might survive future atomic bomb attacks could expect to suffer lingering death



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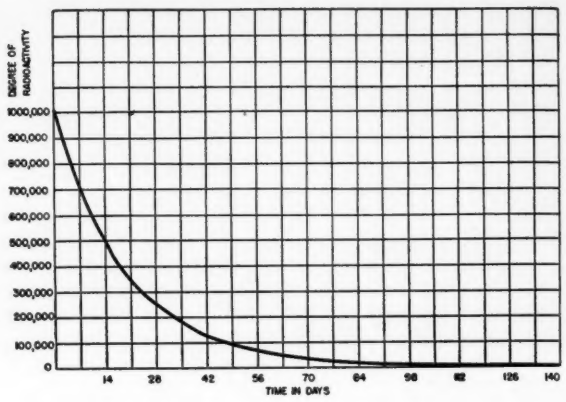
from radioactivity but what was worse, they might live, only to endure the mental torture of not knowing whether they could father normal children.

The inference of all this should be obvious to any intelligent person; when we deal with atomic or more correctly nuclear energy we are dealing with something new on the face of this earth, and we had better be sure that we know what we are doing before we proceed with any large scale development whether it be for power or for war purposes. We may have to pay too big a price for nuclear power.



Curve showing the rate of decay of radioactivity of a radioactive material

Danger from Nuclear Power Development

As has been indicated in previous articles in this section, fundamentally the design of a nuclear power plant is quite simple; it consists of a nuclear reactor operating at a relatively high temperature, a heat exchanger, such as a boiler or gas heater and a steam or gas turbine. The pattern for such a plant is quite clear today; what remains to be done is to solve a number of purely engineering problems concerning temperature, nature of the materials to use, corrosion factors, etc. While these problems are difficult, engineers are confident that they can be solved with time and effort. The problem of what to do with the radioactive by-product of the operation of the reactors is not so easy of solution, and this also is the one which involves the greatest danger. Even if no other atomic bomb is ever dropped, the threat in the use of atomic energy for peaceime purposes remains, until—or if—proper safeguards can be developed.

Writing in the Journal of the American Medical Association, Dr. W. F. Bale, recently questioned whether any large scale use of nuclear power should be permitted. It is quite possible that the continuous use of a number of large power plants would increase the general radioactivity of the earth to such a high degree as to endanger life everywhere on earth. Dr. Bale stresses the fact that any long-term program involves the question of the amount of radiation of atomic nuclear origin to which mass humanity may be subjected above that due to cosmic rays and the normal radioactivity from the earth.

It may be possible to collect the radioactive isotopes produced by nuclear reactors and keep them from spreading out into the atmosphere but they will still have to be disposed of later. Of course, many of them will be short lived—a matter of minutes or a few days. It will be easy to keep them until their activity has diminished to a point where they are no longer dangerous. There will be others, however, which will have much longer lives—some extremely long. Carbon 14, for example, has a half life of 10,000 *years*. Hydrogen 3 has a half life of 31 years. Calcium 45 has a half life of 180 days.

The mere fact that an isotope such as Carbon 14 has a very long half life does not mean that it is necessarily dangerously radioactive. It is dangerous only if the concentration is sufficiently high. Natural uranium, for example, has a half life of some 6 billion years; therefore, in spite of the fact that there is a great deal of uranium in the earth it is not dangerous because it disintegrates so slowly that the radiation has no harmful effect on living things. For the same reason Carbon 14, even though it has a long half life, is not necessarily harmful; it might be, however, if it were present in sufficient concentration and in large amounts. Radioactive sodium Na22 with a half life of 3 years because of its greater activity would be more harmful. There are two radioactive isotopes of sodium; besides the one just mentioned, there is Na24 with a half life of 14.8 hours. The accompanying table shows the half life of a number of the more common radioactive isotopes. The half life of a radioactive element, of course, is the time in which the radioactivity decreases to one half its initial value.

From what has been said here it should be evident that aside from the question of using atomic energy as a war weapon, it is important that the use of atomic energy for peacetime purposes should be under some form of international control. Fortunately, in this country, under the control of the Atomic Energy Commission, the development of atomic energy will be in safe hands. At the present time, the development is in the hands of three large companies, General Electric, Monsanto Chemical, and Fairchild Engine & Airplane Corp. General Electric Co. is operating the Hanford plant in Washington and also will run the Atomic Energy Commission's new Knolls laboratory near Schenectady. Monsanto took over the management of the Clinton laboratory at Oak Ridge in 1945 and, now, is building a smaller laboratory for the AEC at its Dayton research center at Miamisburg, Ohio. Fairchild is the prime contractor for Army Air Forces research on atomic propulsion aircraft.

The scientists doing the work for all of these three companies will be capable and with every resource at their command they will see to it that dangers arising as a result of their work will be kept under control and that no large scale operations are started until they are certain that no harm will come to the people at large. We cannot, however, control the efforts of foreign countries in nuclear research and unless some form of International control is established we can have no assurance that some foreign development will not endanger the lives of all the people in the world. Nuclear energy, like radio waves cannot be confined to the borders of any one nation.

HYDROGEN COOLED GENERATORS

(*Continued from page 82*)

meter for indicating the rate of gas flow through the gas analyzer at all times (replacing the bubbler bottle formerly used, which was used only with generator at standstill); a gas analyzer of improved design, operating on the thermal conductivity principle, with scales for both hydrogen and CO_2; a new alarm system in which an audible alarm is provided to indicate when a fault has cleared, and which employs relays of the plug-in type having dust-tight covers; and solderless terminals in the wiring to eliminate troubles experienced with soldered joints. Front and back views of a hydrogen control cabinet of recent design are shown in Figs. 18, 19.

Operating experience with 108 hydrogen cooled generators in sizes from 15,000 to 150,000 kw has indicated no serious operating difficulties with this type of generator and has fully demonstrated the many benefits obtainable with hydrogen cooling. Recent improvements in the design of hydrogen cooled generators inclure vertical coolers, a new shaft seal, and a system of continuous scavenging through which the vacuum oil treating equipment may be eliminated. The simplification of the auxiliary equipment made possible by the latter development should make the use of hydrogen cooling for generators even more attractive than at present and may reduce the lower limit of size in which hydrogen cooled generators may be economically built.

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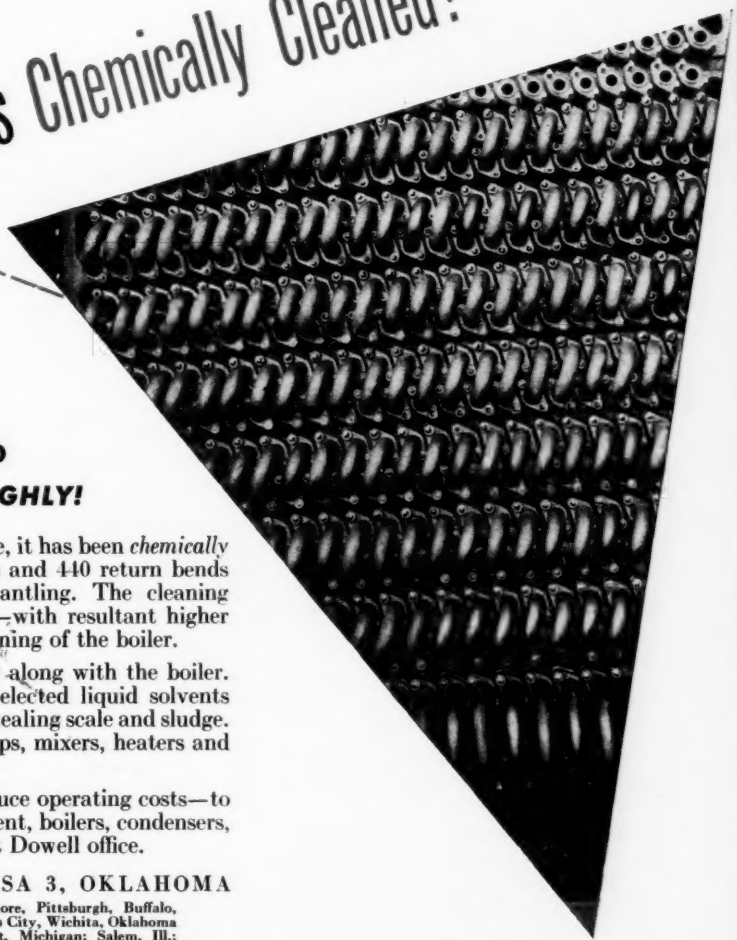

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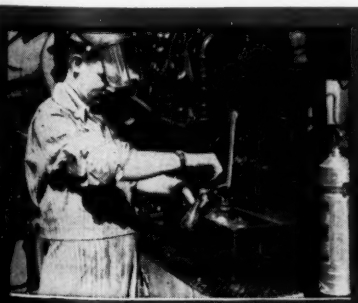

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New Ideas in Power Plant Coal Handling

By **WILBUR G. HUDSON**, Consulting Engineer

Coal handling must be reliable, even though cost is only small fraction of power production cost . . . Here are tips on how to increase that reliability . . . Smaller coal sizes cause trouble in hoppers; what to do about it . . . Further trouble when small sizes are wet or frozen . . . Various heating and "breaking-up" devices now available . . . How twin track hoppers speed up unloading . . . New developments in belt conveyors; stronger carcasses; use of rayon, nylon, glass fiber and steel wire in belts . . . How to improve drives . . . Better coal chutes for wet or frozen coal . . . How to lessen dangers of coal dust explosions . . . Review of storage methods for dry and wet coal

IN THE MODERN power generating plant, the coal handling cost is but a small fraction of total production cost per kilowatt-hour output, but the coal handling installation is nevertheless important, especially as regards reliability. Repeated interruptions of service due to coal-handling system breakdowns are an annoyance and upset planned schedules. Coal that should go direct from cars to bunker must go to reserve storage and from reserve storage to bunker, often doubling the per ton handling cost.

Illustrating the costs in a pulverized-coal-burning station of excellent efficiency, where the coal handling equipment cost approximately $150,000, the following is of interest. The ascertained labor cost was 8.7 cents per ton, to which the routine is to add: for taxes and insurance 2 per cent; depreciation 7 per cent; interest 5 per cent; and maintenance 2 per cent, making the total annual cost for coal handling 24.2 cents per ton. The operating figures are:

Net kw-hr output	350,400,000
Fuel Cost	$769,400.
Fuel cost per kwhr	0.220 cents
Labor and supplies	$74,200.
Cost per kw-hr output	0.021 cents
Maintenance	$117,600.
Cost per kw-hr output	0.033 cents
Total production cost	$961,300.
Cost per kw-hr output	0.274 cents
Coal cost per ton	$4.90
Lb coal per kw-hr	0.896 pounds
Total coal consumed	157,046 tons
Total annual charge for handling coal	$38,000.

The total annual cost for coal handling, $38,000, is 4 per cent of the total production cost, $961,300.

Smaller and Wetter Coal is the Villain of the Piece

With the general use of small steam sizes (⅜ x 0 and smaller) have come difficulties that previously were negligible. Trouble starts right at the receiving end. Such coal has about the same angle of repose as larger coal when it is clean and dry, but usually it is neither clean or dry, flows sluggishly and has an angle of repose of about 80 deg. Track hoppers have long been standardized at about 12 by 12 ft in plan, with sides sloping at 45 deg. This was satisfactory with mine-run coal, but these small sizes back up along the valley angles and restrict the flow from the car. For these small sizes, track hopper sides must be steeper, with valley angles at least 45 deg, and even steeper if possible.

This is not the first bottleneck, however. With dry free-flowing mine run or slack coal it is not unusual to unload four 70-ton cars per hour with a good squad of four men, through a 12 by 12 ft track hopper. But the small sizes of damp coal must be spaded out, and often several hours are required for a single car. Under the winter conditions to which we of the Middle West are accustomed, unloading of such coal is a slow process.

A thawing shed [1] is too costly except for very large tonnages. For moderate capacities, several probe pipes fed with live steam through flexible hose will do the job.

Radiant Pits for Thawing

A recently developed radiant heat device [2] has promise. This has opposed gas or oil burners in an open firebox located between ties in the railroad track, preferably a car length ahead of the track hopper. The intense heat within the combustion chamber is radiated upward and can be adjusted so the paint on the car will not be scorched —much. It is claimed that a thoroughly-frozen carload can be thawed in ½ hr with a fuel consumption of 9 to 12 gal of oil or the equivalent in gas, at a cost of about $1.00 per car.

"Breaker-Uppers"

If the load is not frozen solidly, or can be classed as sticky, there are three devices available as shown in Fig. 1. The Robins "Shakeout" is a heavy yoke, Fig. 1-C, which is rested on the car sides and agitated by an electric vibrator. The Stephens-Adamson "Accelerator" has four augers, Fig. 1-A and B, which bore into the load down to the gates.[3] The Link-Belt "Displacer" is a heavy spud, Fig. 1-D, which slices off the coal and loosens it to a more flowable condition. It somewhat resembles an effective spud once manufactured by the Brown Hoist Co. in which the chisel was also vibrated by compressed air as it forced its way through the coal.

Even the rotary car dumper has trouble with wet frozen coal. The author has seen cars from a strip mine in Illinois inverted in a dumper, with gobs of coal sticking to the sides solidly. Electric vibrators hung on the sides had no effect. The gobs had to be chiseled off.

Advantages of Twin Track Hoppers

If the rated capacity of the conveying system is 200 tons per hour and it requires normally more than ¼ hr to empty a 50-ton car, there is a distinct advantage in twin track hoppers with alternate dumping. If the coal is only moderately frozen, six men can unload 2 cars per hour if two others thaw the gates before the cars are spotted. If the coal is free-flowing, a squad can easily maintain the 200 tph rate through twin hoppers with a feeder set to that rate.

The hoppers should preferably taper to a single feed-out point. When there are two feed points, the flow from the rear hopper will block off the flow from the front hopper, which thus cannot empty until the other has cleared. The advantage in maintaining unloading operations at the capacity of the conveying system is that handling at reduced capacity reduces the life of the belt as related to the total tons it can handle, increases the maintenance cost per ton, and the labor cost per ton. If the track hoppers are deep, with steep sides, the loads can be dropped more rapidly and the empties passed along.

Passing to the usual belt conveyor system we find interesting engineering

[1] POWER PLANT ENGINEERING, May 1946, page 80, Report of Midwest Power Conference. Alf Kolflat of Sargent & Lundy discussed the many serious power plant design problems arising from coal handling and particularly from wet and frozen coal. Among other things, he suggested that electrical engineers might well devote some thought to design of a chamber using high frequency heating for thawing large masses of frozen coal. There is no evidence that this has yet been tried. In one plant, however, some brief experiments have been made with a battery of infra-red lamps for warming up frozen coal cars, but these experiments are somewhat inconclusive at present—Ed.

[2] *Ibid;* Radiant Heat Thaws Frozen Coal Cars; March 1946, page 69.

[3] *Ibid;* Unloading Fine Wet Coal with the Material Accelerator; October 1944, page 88.

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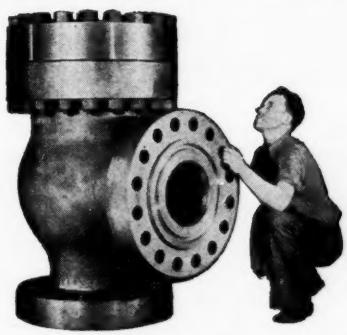

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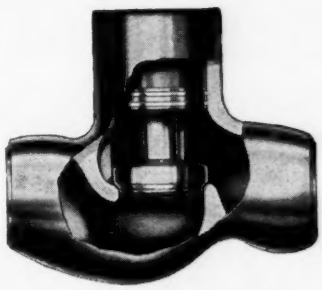

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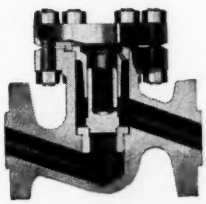

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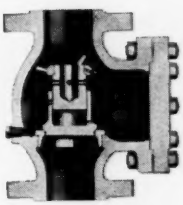

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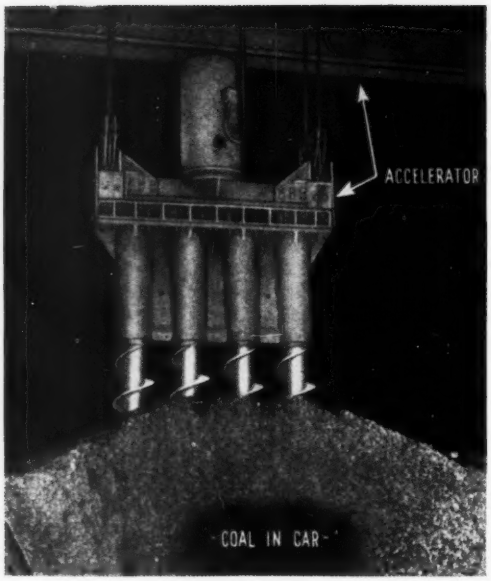
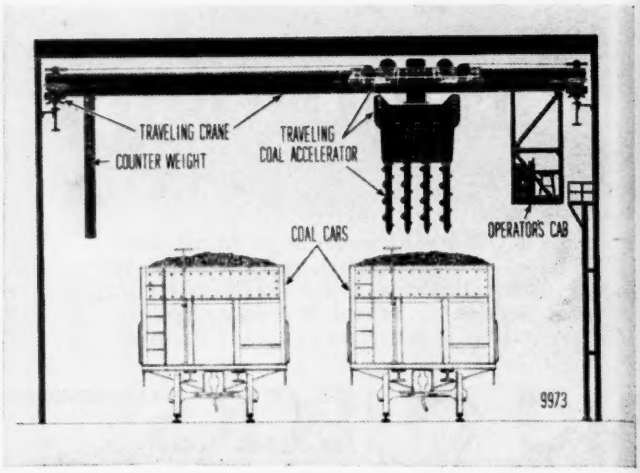
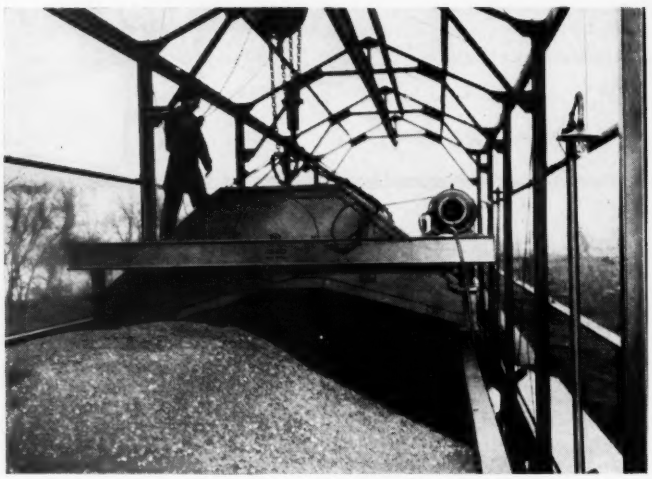




A—Left—The Stephens-Adamson Mfg. Co. "Accelerator." Vertical screws drive down through the coal mass to loosen it into flowable condition. Hoist raises and lowers screws as desired. B—above—The accelerator as installed at Logan, W.Va., showing how it can move across a series of tracks to operate in any of several cars, also how it can be moved lengthwise of cars by traveling crane

C—below—The Robins Conveyors Corp. "Shake-out." The heavy yoke is rested on the car sides and is agitated by a vibrator, to shake the coal loose so it will flow through the gates. D—right—The Link-Belt Co. "Displacer." The "spud" slices off the coal and breaks up the mass so coal will flow through gates



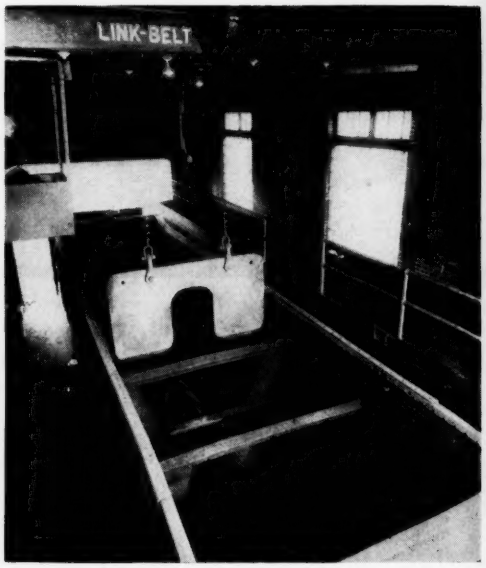


Fig. 1. Extensive use of small steam sizes of bituminous coals, often wet and not flowable, has made it necessary to provide mechanical devices that will reduce labor costs otherwise involved in car unloading

developments. We have been working with allowable cotton duck tensions in which the maximum stresses were:

Wt. of duck, Ounces	Max. lb per inch per ply
28	25
32	30
36	35
42	45

The standard belts were in four classifications based on the quality of the rubber cover and suited to the severity of service. Briefly these were: (a) Light service—wood chips, paper strips etc—usually with 1/16-in. cover. (b) Light lumpy materials not abrasive, 1/8 to 3/16-in. cover. (c) Sand, coke, gravel, etc. with 3/16 to 1/4-in. cover. (d) Crushed stone, ores, etc. with 3/8-in. cover or more. Steam plant coal handling usually called for the (b) to (c) classification. The war abruptly curtailed the use of natural rubber and none of the pre-war grades were permitted. The natural rubber content was limited to 5 per cent, the balance to be synthetic rubber. When the war ended the reversal to natural rubber began, but the improvements in the synthetics have been striking and how far the wartime construction will now go cannot be foreseen. Much depends on relative future costs. At present the manufacturers are increasing the natural rubber content as fast as they can, but for some purposes the Neoprene class of cover is better than the natural rubber, as, for example, in its heat- and oil-resistant qualities.

Still more interesting as affecting the future of the belt conveyor is the current research for a stronger carcass construction than can be provided by natural cotton fiber or duck. With the increases in cost of cotton, natural substitutes are rayon and nylon. It is possible at present to attain a given strength with rayon at less cost than with cotton because of the far greater fiber strength of the former. Its fiber is so smooth that it is difficult to get adhesion to the rubber but this problem has been solved. It does have one disadvantage: that the strength decreases about 40 per cent when it is water-soaked, and this may happen through cuts in the cover. Nylon fiber has remarkable strength and is not affected by moisture.

Worth looking into

When you look into the AMEROID system you'll find it backed by all the factors necessary for a completely successful boiler water treatment . . . a national service organization of trained chemists and engineers; modern analytical laboratories; controlled manufacturing facilities; a progressive research program; and the "know how" that comes only from wide experience. An AMEROID representative will be happy to discuss boiler water conditioning with you at your convenience.

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It has an excessive stretch under load and a gradual increase in length with service, calling for much greater travel allowance in the take-ups. Nylon belts are in use experimentally and have demonstrated excellent ageing qualities and resistance to mildew.

Glass fiber is under investigation, for it too has great strength combined with resistance to mildew and chemical deterioration, and a very low coeffiecient of elongation. Finally, where extreme length is involved, the belt is now constructed with parallel steel wire cables taking the pull. These are similar to airplane control cables, electroplated with copper and embedded in rubber. Such belts are made for working stresses of 1000, 2000, and 3000 lb per in. of belt width. This loading is far beyond that involved in power plant coal-handling installations, but is of great importance in connection with conveying ore from deep pits to the surface, much less costly than railroad cars and locomotives now that conveyors can be built to sustain the heavy loadings involved.

Of considerable interest is the cord belt in which the carcass is built up in multiple layers of small diameter cords embedded in rubber. These cord belts are rated for 50, 70, and 100 lb tension per inch width per ply. Referring to the table above for maximum stresses with duck, if we have a maximum belt tension of 10,800 lb in a conveyor for 200 tph of coal, we would select a 30-in. belt, 8 ply, 42 oz duck; speed 300 fpm Now we can do the job with the 4-ply cord belt. In fact we can specify a 24-in., 5-ply cord belt at 450 fpm.

Drive Improvements

Improvement in heavy duty drives is attained by lagging the head and snub pulleys with a grooved rubber cover, vulcanized on. The lagging has a 2-ply, 36-oz base with ⅜-in. cover on the top side, in which is a transcord breaker strip next to the fabric providing an absolute bond between the two. The grooves are ¼ in. wide by ¼ in. deep, either parallel with the shaft or diagonally, as in a herringbone gear. The

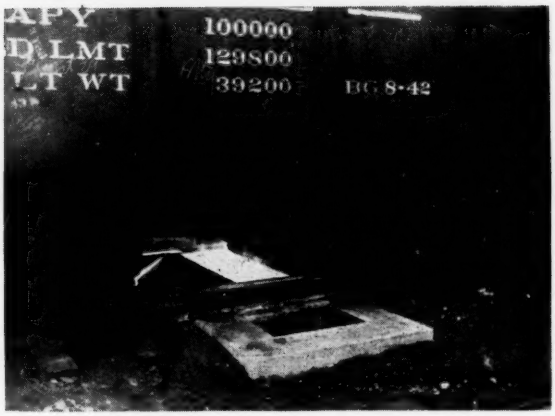


Fig. 2. A radiant coal car heating pit as designed by Hauk Mfg. Co.

squeegee effect of the grooved lagging is to wipe a wet surface dry, preventing slip and reducing creep. The snub pulley lagging in contact with the carrying side of the belt functions to prevent build-up of dirt. This type of drive pulley eliminates the necessity of a dual motor drive in practically any inclined conveyor involved in steam plant practice.

Improving Coal Flow from Bunkers

Perhaps the toughest job today is getting damp small sizes of coal from the bunker to the pulverizers. If the coal has been brought in from outside storage where it has been rained on, perhaps ground up by the treads of a bulldozer, or sometimes frozen into hard lumps, it is sticky and will not flow through the mill feed chutes. Extended research was done by E. F. Wolf and N. L. Von Hohenleiten on this problem and the results of their laboratory experiments to secure a design of chute which would reduce this difficulty were given[4] at length before the ASME, also in these columns.

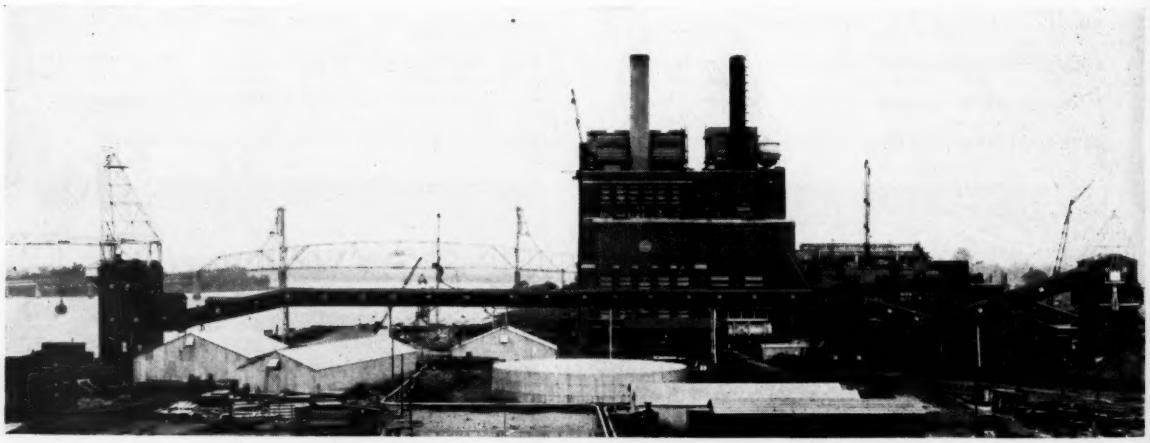
If such coal, en-route to the bunker, could be passed through a rotary dryer, the difficulty could be substantially reduced, for even the smallest sizes are flowable when the surface moisture is less than 5 per cent. But the handling rate from car to bunker seldom is less than 60 tph and a dryer installation for such capacities involves prohibitive investment. Since the handling rate from bunker to pulverizers is always a small fraction of the rate to the bunker, the solution may be in drying in that stage. There are several methods for maintaining the flow of freshly deposited coal from the bunker, if not too wet; for example, a horizontal run-around continuous-flow conveyor with multiple feed-in openings and auxiliary vibrators to break down the ratholes. The dryer then would have a reasonably small capacity and its output would be distributed to the mill chutes by a second run-around conveyor. The speed of the conveyor feeding to the dryer can be controlled automatically by the height of the load in the second run-around, that is, by the demand of the pulverizers.

[4] *Ibid;* Flow of Coal in Chutes; July 1945, page 93, also Transactions ASME, October 1945, Vol. 67, No. 7.

Reducing the Dust Hazard

There is now recognition of the dust explosion hazard in materials handling. A long conveyor gallery, unless blocked off by spaced partitions or well ventilated, may become filled throughout its length with fine coal dust generated at

Fig. 3. Good housekeeping in housed coal handling structures is vital to clean up and prevent deposits of coal dust. If there is a chance of ignition around crushers and at chutes or beneath hoppers, dust deposits might be puffed into suspension and exploded



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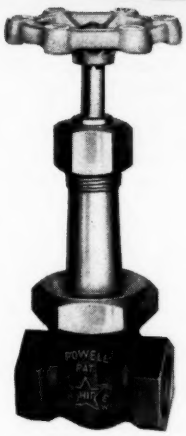


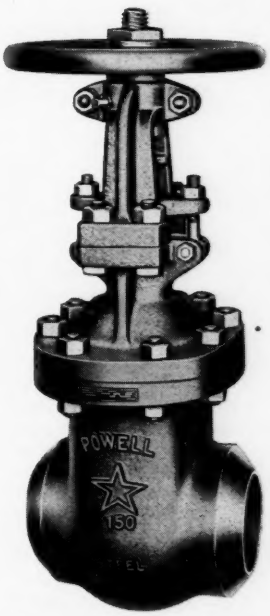
Small size 200-pound Bronze Gate Valve for steam, water, oil or gas. Has inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel-bronze disc.

'Way back in the "horse and buggy days", the first regrinding globe valve was produced and patented by Powell. And ever since then Powell has been a leader in the field of industrial flow control equipment.

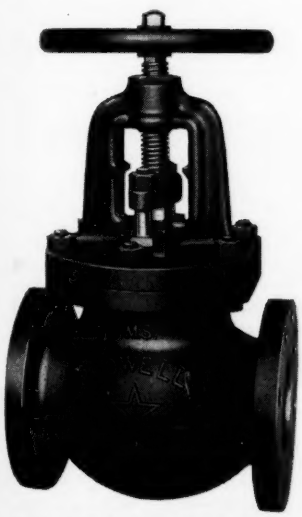
As amazing as the changes in methods of transportation have been since 1846, the progress of industry has been well nigh incredible.

Through more than a century of keeping pace with the flow control requirements of each new industrial development, Powell has built such a complete line that today there's a Powell Valve to meet every demand of modern industry.

The Line now includes Bronze and Iron Valves of every required type, design and size; Cast Steel Valves of every type, in pressure classes from 150 to 2500 pounds, inclusive. And, to meet the demands of the Chemical and Process Industries for corrosion resistant valves, Powell makes a complete line, including many special designs, in the widest range of pure metals and alloys ever used in making valves.



Class 150-pound Cast Steel Gate Valve with welding ends, bolted flanged yoke, outside screw rising stem and taper wedge solid disc.



Large Iron Body Bronze Mounted Globe Valve for 125 pounds W.S.P. Made in sizes 2" to 16", inclusive. Has outside screw rising stem, bolted flanged yoke and regrindable, renewable bronze seat and disc. Also available in All Iron.

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POWELL VALVES

the Bradford breaker or the hammermill. This dust accumulates on the bracing, ledges, conveyor supports, and the like. The dust actually in suspension in the air cannot be in sufficient density to form a fire risk (about 0.05 oz per cu ft of air is a minimum). But local dust clouds of dangerous density may form at chutes or beneath the crusher and may ignite if a spark should be struck by a fragment of steel, or may ignite from a short circuit or open flame. The shock wave or puff from such localized explosion throws accumulations of dust into suspension, and ignition may extend throughout the crusher house and along the conveyor gallery. This sequence no doubt is the explanation of some of the disastrous explosions that occur where coal and other dust concentrations are present in crushing and grinding operations. Venting and clean-up of dust accumulations are well worth while where such hazards are possible.

Another dust generator is the traveling weigh hopper. In one stoker-equipped plant where the coal is dry and dusty, the author observed that when the hopper was loading, the dust cloud was so dense that visibility was reduced to about 30 ft. It made one feel a little uncomfortable to stand by and watch this dust cloud float into the glowing furnace.

Comments on Modern Coal Storage

General recognition of the advantage of stocking [5] reserve coal, that has some risk of spontaneous heating, in rolled layers, has extended the use of the bulldozer and similar machines. Loss in heating values by weathering is small as a rule. Extended research by the United States Bureau of Mines with New River, Pocohontas, Pittsburgh Gas, and Sheridan, Wyoming coals has shown that outdoor weathering caused no loss greater than 1.2 per cent the first year or 2.1 per cent in two years. The subbituminous Wyoming coal suffered a somewhat greater loss—2 per cent to 3 per cent the first year and up to 5½ per cent in three years.

The bulldozer is strictly a pusher. It does not transport its load, but pushes it ahead, spilling some around the edges and replacing the spillage as it moves forward. It is best for short trips. The handling capacity of a large bulldozer ranges from 136 tpm on a 50-ft haul down to 50 tph on a 200-ft haul. A 100-hp motorized unit will show an operating cost of about $4.50 per hour including labor, depreciation, interest, insurance, fuel and oil and maintenance. For the small plant the dozer blade is easily fitted to a small tractor and makes a good piece of equipment also for miscellaneous jobs, such as car shifting.

The tractor scraper is a rubber-tired scraper hitched to a caterpillar or track-type tractor. It loads, transports and spreads the coal evenly in one operating cycle. The 100-hp machine costs about $10,000.

[5] *Ibid;* Coal Storage Manual; July, 1942.

The carryall is a self-loading, self-discharging carrier towed either by a track-type or rubber-tired prime mover. It is intended for a longer range of action. For most active duty, it should be assisted by one or two bulldozers. A 100-hp tractor with 10-ton capacity carryall costs about $15,000. (Note—The prices mentioned are 1946 figures and probably should be increased now.)

Silo storage involves some factors of interest. Here again the damp small sizes of bituminous are troublesome. The coal backs up and arches, as a silo rated for 300 tons capacity may actually show less than 150 tons working capacity. The silo contractor cannot be criticized for specifying a proposed silo as of so many cubic feet of storage volume rather than as having a stated live storage capacity.

With dry coal there is another factor, which is this: The drop from the elevator segregates the mass—the lumpy coal toward the wall and the fines in the central zone. Air circulates upward from the discharge gates and, if the coal oxidizes easily, somewhere there is a zone where conditions favor spontaneous heating. If the temperature increases sufficiently, ignition may occur and explode the gas that has accumulated above. Even though an explosion should not occur, the clinker formed at the discharge openings is difficult to break up. The gates should have seals or the closest possible clearances where such coal is expected.

MORE POWER FOR BOSTON

(Continued from page 71)

of the conveyors which is now limited to 350 tons per hour. With coal not too heavily frozen the shaker would remove nearly all the coal in about the same time. However, much of the frozen coal comes out in pieces too large to pass the hopper grid and hand work is required to break up the lumps. The shaker by itself will not remove coal frozen solidly to car bottoms and lower sides, but it is expected that the thawing pits will assist in this problem when severe weather is encountered.

Coal Silos

Each boiler is supplied with coal from three reinforced concrete silos 16 ft 6 in. inside diameter by approximately 50 ft high, each silo having a capacity of 250 tons of coal. The silo walls are six inches thick and the bottoms are conical with a slope of about 60 degrees. The conveyor housing above the silos is heated and the cone ends project down about half way into a heated room. The shafts of the silos are exposed to the weather at the northeast face of the building, but no difficulties with freezing of the coal have been encountered. More as a precaution than as a requirement, compressed air connections with quick opening valves have been installed in the lower cone sections to guard against "rat holing" if it should occur. This arrangement was tried out and proved on a large rectangular concrete bunker in which the coal arched in the valley angles of the prism-shaped outlet sections so that the flow of coal to the mills ceased even though many tons of it remained in the bunker.

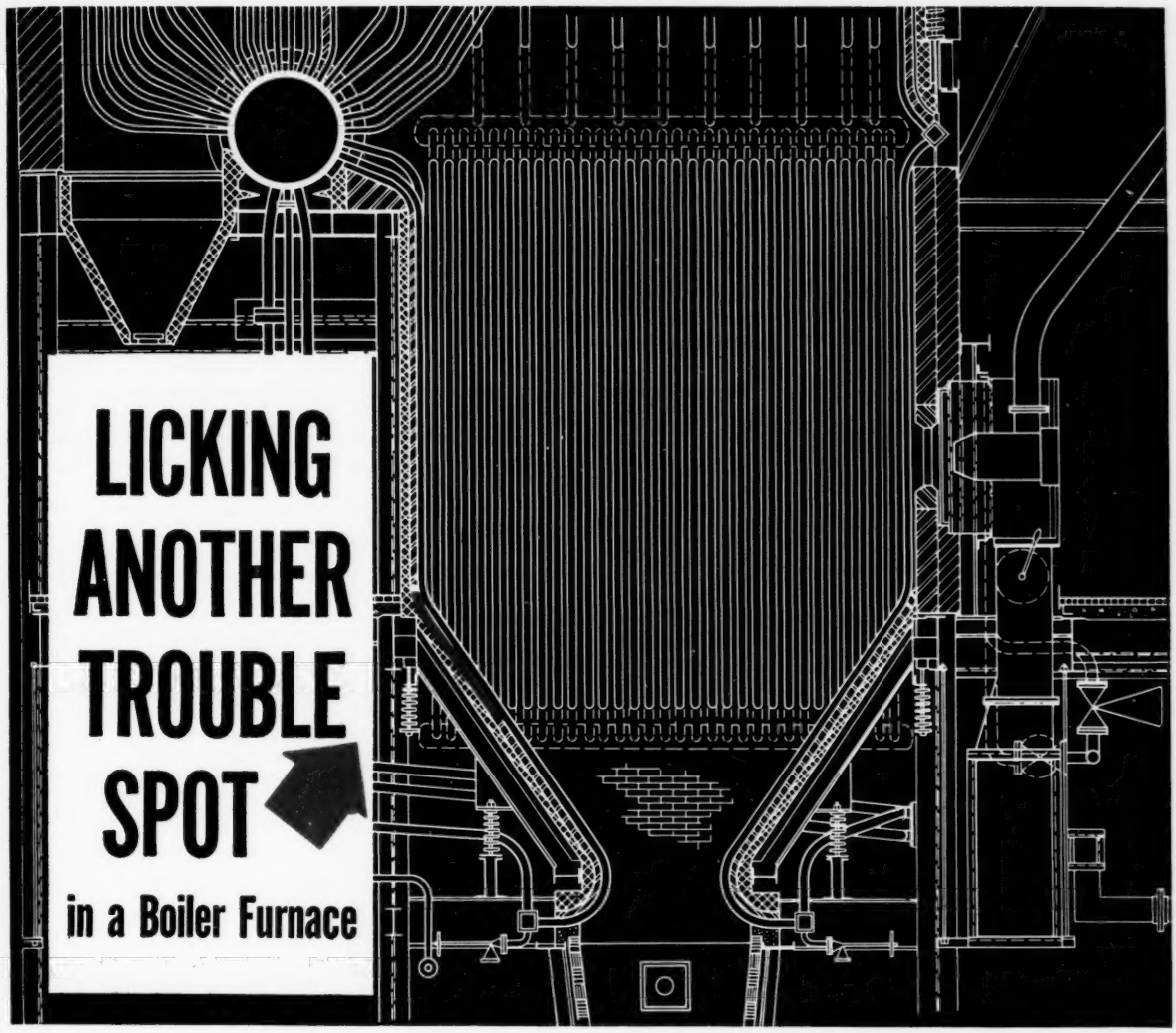
The silos, constructed by specialists in the work, are less expensive to install than other types of storage bins and have been entirely satisfactory in service in spite of the rigors of the climate which had caused some apprehension.

A frequent source of difficulty in pulverized coal installations is found in the discharge pipes from the feeders to the mills where the coal frequently falls freely a distance of four feet or more to impinge upon the inner walls of the discharge pipes. The pipes may be eroded through in a few months as were those at Mystic. The solution to the problem has been the installation of wire reinforced rubber pipes made straight and bent in place, to meet the flange faces at the end connections. No difficulty with erosion or with coal sticking or "hanging up" in the rubber pipes has been experienced: If erosion should occur the rubber pipes can be quarter-turned three times to prolong greatly their useful life.

Plant Ventilation System

One of the unusual features of the Mystic Station is the cross flow ventilation system incorporated in the design. With no wall between the turbine and boiler rooms and with the turbine room on the side toward the prevailing summer wind, it was feasible to provide for a cross flow of air from the turbine room through the boiler room by installing virtually complete solid floors at several elevations and by furnishing a number of large capacity fans in the east wall of the boiler room. Below the solid fan deck which isolates the top of the boiler two solid floors divide the boiler room into three tiers open to the turbine room. Ventilating fans in the east wall in each of the tiers assure positive cross flow at each of the three levels. The forced draft fans in the fan room are located near the east wall and draw air from the room. The quantity of air drawn into and across this room is ample to ventilate it adequately. Although stair openings are provided in the solid floors the upward flow of warm air is slight and the system functions to the satisfaction of the designers and of the operating personnel.

The general ventilating system is supplemented by an arrangement of a blower and ducts for directing air near the top of each boiler to the walkway from which the tops of the superheater elements would be lanced. During the three years of plant operation it has not been necessary to lance the superheaters and this part of the ventilating system has not been needed for its primary purpose. However, when maintenance work is in progress at the top of the boiler during warm weather the blower system is usually operated to augment the main system.



LICKING ANOTHER TROUBLE SPOT

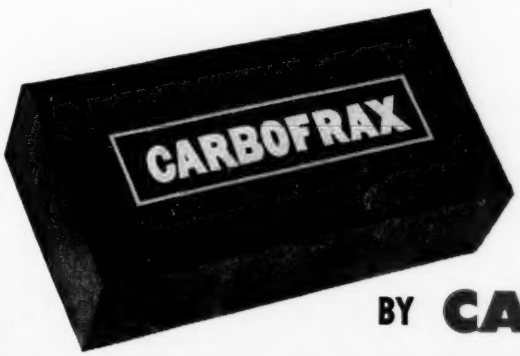
in a Boiler Furnace

The small area, spotlighted in red above, was a source of constant difficulty until it was corrected by the installation of CARBOFRAX silicon carbide blocks.

Slag conditions were particularly bad. Excessive accumulations built up on cast iron blocks located behind and between water tubes. Cleaning with air lances oxidized the metal blocks. Burning thin, they no longer protected backing up refractories and insulation which were soon eroded by impinging flame.

CARBOFRAX blocks have now been in service over four years . . . more than twice the life of metal blocks. Their appearance indicates several years additional usage. Costly repairs are eliminated by their outstanding refractoriness . . . resistance to slag penetration and erosion . . . and durability. Continuity of operation is improved. When running on light loads, the radiant face of CARBOFRAX blocks helps maintain ignition.

Trouble spots, in many cases, disappear with CARBOFRAX super refractories on the job. Investigate their use in your settings. Write Dept. H-67 for prompt attention. The Carborundum Company, Perth Amboy, New Jersey.



BY **CARBORUNDUM**
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How Chlorine Kills Ammonia in Boiler Feedwater

Ammonia in steam comes originally from raw water . . . Causes corrosion in steam-condensate systems, boiler deposits, high maintenance and replacement costs . . . Proper chlorination of feedwater destroys most of ammonia, eliminates trouble it causes . . . How it was done in one plant . . . Breakpoint chlorination removed all but slight traces of ammonia . . . Required 1.4 ppm lime and 1.4 ppm soda per ppm of chlorine to maintain lime-soda softener balance . . . No chlorine residual imparted to deaerated feedwater . . . Ammonia originally present gradually reduced by blowdown and leakage and make-up was from source of water free of ammonia.[1]

THE PRESENCE of ammonia in steam has been recognized as the cause of corrosion of copper and copper alloys in steam-condensate systems. Excessive maintenance and replacement costs have been caused by high ammonia concentrations. Boiler deposits containing copper are frequently found in plants where the ammonia concentration of the steam in the condensate has resulted in corrosion and the subsequent introduction of dissolved copper into the boiler via the condensate returns. Corrosion due to free ammonia occurs particularly at points of partial or complete condensation of the steam, thus permitting concentrations of ammonia in the liquid phase.

Practically all natural waters contain traces of ammonium salts (usually present as ammonium carbonate). An increase in the sewage or trade waste contamination of a water supply will effect an increase in the ammonia content of the water. Ordinarily, ammonia is present in water as free ammonia and albuminoid ammonia.

"Free Ammonia," by definition, is that quantity of ammonia which, upon distillation with or without the addition of alkali, is carried over in the distillate. The quantity of ammonia obtained on continued distillation with a strongly alkaline potassium permanganate solution is referred to as "albuminoid ammonia." This latter quantity of ammonia does not exist in the water as ammonia but is formed by the decomposition of nitrogenous organic matter when treated with an alkaline potassium permanganate solution.

Rain and snow carry traces of "Free Ammonia" and although the amount is variable, a figure of 0.006 ppm can be considered as average. Decaying animal and vegetable matter, sewage and all fertile soils contain ammonia. Nitrates upon reduction yield ammonia, hence, when nitrate containing water passes through ferruginous sands or considerable lengths of metal piping, ammonia may be present due to the reduction of the nitrates. Some low forms of life (*crenothrix*) can produce ammonia; however, the method of production has not been definitly ascertained.

Results of laboratory experiments conducted by Wallace and Tiernan[2] indicated that chlorine, when applied in sufficient dosages, will react with the free ammonia present in water thus resulting in its elimination. By maintaining free available chlorine residuals, the destruction of the greater quantity of the ammonia originally present is assured, since the existence of free-chlorine and free-ammonia residuals in the same solution is not normal. Thus breakpoint chlorination is used to destroy ammonia along with bacteria.

Laboratory results indicated that maximum chlorine and ammonia removal is accomplished between a pH of 7.0 and 8.0. However, chlorination is actually effective over the wider pH range of 6.5 to 8.5. In laboratory tests, gallon containers of distilled water (temperature 45 F. to 48 F.) containing 0.50 ppm of ammonia were employed, buffered to pH values between 5.0 and 9.0. Varying concentrations of chlorine, as chlorine water, were added and chlorine residuals determined on the various samples after 20-minute, 2-hour and 24-hour retention periods. A ratio of ammonia to chlorine of 1:10 was found to be required for the removal of the ammonium ion on a laboratory scale. It was found that in addition to pH, the reaction is also dependent upon time.

Table I. Average analysis of Calumet River water

Hardness as $CaCO_3$	186	ppm
Calcium as $CaCO_3$	145	ppm
Magnesium as $CaCO_3$	41	ppm
P Alkalinity as $CaCO_3$	0	ppm
M Alkalinity as $CaCO_3$	105	ppm
Sulfate as SO_4	92	ppm
Chloride as Cl	12	ppm
Ammonia nitrogen as N	1.7	ppm
pH	7.5	

Before the effect of chlorine on ammonia removal could be determined on a plant scale, a number of factors had to be investigated such as:

1. Possible interference of the process with subsequent treatment methods.
2. Chlorine dosages required to ef-

[1] From *The Betz Indicator*, February 1947, Vol. 16, No. 2.

[2] Described in Proceedings of 5th Annual Water Conference, Engineers' Society of Western Pennsylvania.

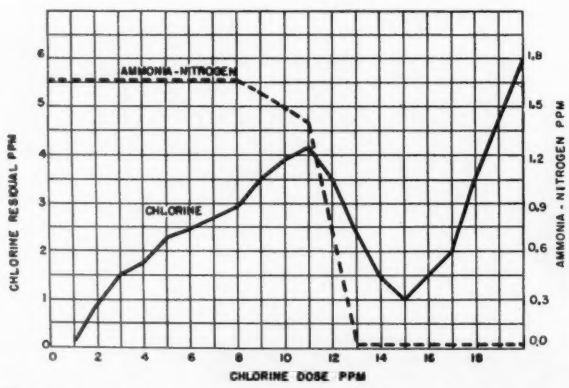


Fig. 1. Ammonia-nitrogen and chlorine residuals of Calumet River water; pH = 7.6

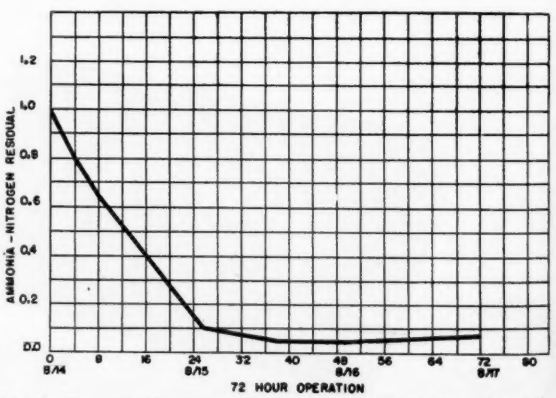
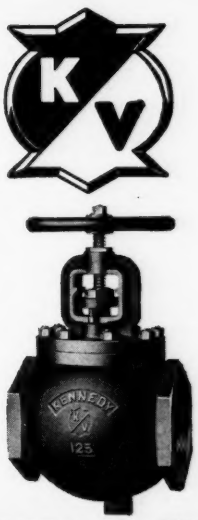
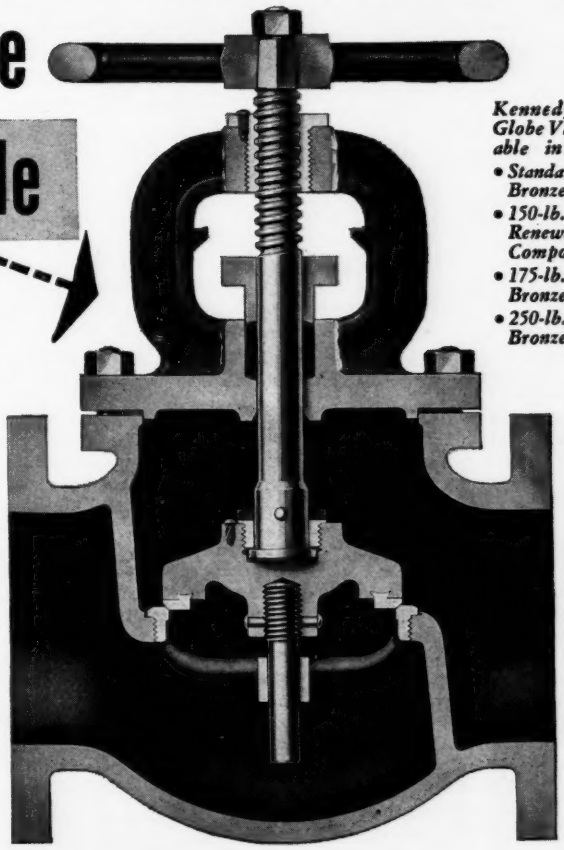


Fig. 2. Ammonia-nitrogen residuals of filter effluent from hot lime soda softener

This on the outside



means stamina on the inside



Kennedy Iron-body Globe Valves are available in these types:

- *Standard with Bronze-faced Discs*
- *150-lb., with Renewable Composition Discs*
- *175-lb., with Bronze-faced Discs*
- *250-lb., with Bronze-faced Discs*

The stamina you get in all Kennedy Valves is the product of experience, intelligent design and tough metal. Evidence . . . this Kennedy Iron-body Globe Valve. Note the generously proportioned body . . . the thick sections of dense, homogeneous, high-strength cast iron . . . the sturdy ribbed yoke.

These are but three of the many features you get when the name Kennedy is on the outside of the valve you buy. For the whole story on Kennedy Valves, write for the 240-page catalog describing the full Kennedy line of bronze and iron-body gate, globe, angle and check valves, pipe fittings, flanges and other valves and accessories.

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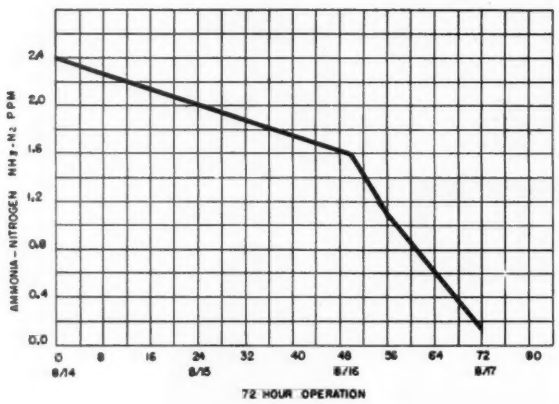

Fig. 3. Ammonia-nitrogen residuals of returned condensate

fect ammonia removal on a plant scale as well as the residual chlorine content with the required dosages.

3. Efficiency and completeness of ammonia removal under conditions of continuous flow and continuous chlorine application.
4. Effect of chlorination on the operation of hot process lime-soda softening.
5. Effect of the treatment on the final feedwater.

A practical application of the use of chlorine for the removal of ammonia was conducted at a plant employing Calumet River water for boiler feed purposes. This test was conducted by Betz engineers in cooperation with Wallace and Tiernan and the plant personnel. An average analysis of this water is shown in Table I.

Although the average ammonia nitrogen value of the river water was 1.7 ppm at the time of the test, ammonia had previously been determined as high as 2.5 ppm. It will be noted that the pH value of 7.5 lies midway between the limits shown by laboratory work to give maximum removal of chlorine and ammonia. Laboratory tests were first conducted on the river water at the plant site, using increasing dosages of chlorine and determining the chlorine residual after 5-minute contact periods. Dosages employed were from 1 ppm to 20 ppm. These results are shown in Fig. 1.

Plant Make-up Treatment

At the plant, boiler make-up is hot lime-soda softened, filtered and mixed with hot returned condensate. Before softening, raw water enters a mixing tank to which city water is added at times of emergency. Depending on plant demand, retention time in the mixing tank varies from 4.5 to 7.5 minutes. Since laboratory tests indicated that chlorination should be effected on water with a pH between 6.5 and 8.5, the mixing tank provided the most suitable point for the introduction of chlorine gas.

Upon entering the mixing tank, water discharges downward, falling freely through the air to the water surface in the tank, thus effecting some degree of aeration of the water within the tank. This aeration makes possible the postulated reaction between the monochloramine and oxygen with the formation of hydrochloric acid and nitrogen.

$$1—Cl_2 + H_2O \rightarrow HOCl + HCl$$
$$2—NH_3 + HOCl \rightarrow NH_2Cl + H_2O$$
$$3—2NH_2Cl + O \rightarrow 2HCl + N_2 + H_2O$$

On a plant scale, tests of 8-hour duration were conducted on each of three successive days. Variations in chlorine dosages between 8 ppm and 19 ppm were made and residual ammonia determined on the water leaving the mixing tank. The results obtained are summarized in Table II.

Figuring the Break-Point

It was indicated then that the greatest efficiency of ammonia removal occurred with a chlorine dosage of 13 ppm and a chlorine to ammonia ratio of 8:1 gave as complete a reduction as could be effected by larger dosages of chlorine. Thus break-point chlorination must be applied to this water to effect any substantial reduction in ammonia content.

During the three-day (8 hours per day) test period, the filter effluent was analyzed at intervals for ammonia content. A reduction in this ammonia content was noted as the test progressed, however, the ammonia concentration after the filter effluent did not decrease in proportion to the reduction in the ammonia content of the mixing tank water. It appeared as though this discrepancy was due to the probable presence of ammonia in the filter bed being removed at a relatively low rate of dilution.

In order to provide against any possible corrosive qualities that might be imparted to the boiler feedwater by the presence of free chlorine, tests were conducted for residual chlorine on the outlet of the hot process softener. Chlorine was found to be absent in all the samples tested. The physical arrangement and sampling points available did not permit sampling the water between the entrance point to the softener and its outlet from the treated water make-up deaerated storage section. Since a residual chlorine content was found on the outlet of the raw water mixing tank, but the chlorine was absent from the water leaving the softener, that chlorine was consumed or expelled from the water during its passage through the softener. This action could take place in the heating section or in the reaction section or both.

Testing for Results

To assure that break-point chlorination could satisfactorily reduce the ammonia content of the filtered water, a 72-hour test was conducted with a chlorine feed of 13 ppm (chlorine to ammonia ratio of 8:1). At the end of the first 24 hours, a 90 per cent reduction in ammonia content of the filter effluent was observed and as the test progressed, the ammonia value dropped to 0.05 ppm. The quantities of residual ammonia found on the filter effluent over a 72-hour period are plotted on Fig. 2.

Ammonia determinations were also made on samples from the condensate storage tank during the 72-hour test period. The ammonia content was 2.4 ppm at the start of the test; however, this value was reduced to 0.15 ppm at the end of the test run. Results of these determinations are plotted on Fig. 3.

The relatively slow rate of reduction of ammonia in the condensate is due to the presence of a certain quantity of ammonia in the steam system at the start of the test. This quantity of ammonia would remain with the condensate. Initial concentrations of ammonia can be reduced only by blowing down the boilers, by steam and condensate losses from the system and by using a make-up water that is relatively free of ammonia. Therefore, the dilution method of removing ammonia from a large quantity of condensate is a slow process. Ammonia can be eliminated from the condensate if ammonia-free feedwater is employed for a reasonable length of time. However, the ammonia content would increase immediately upon the introduction of make-up water containing ammonia.

In order to maintain the normal chemical balances on the softener effluent, an increase in the feed of lime and soda ash was necessary during the test periods. For each ppm of chlorine fed, an increase of 1.4 ppm of lime and 1.4

Table II. Results of tests to determine effects of varying chlorine dosage on water leaving mixing tank

Raw Water Ammonia	Chlorine Applied	Cl to NH_3 Ratio	NH_3 Nitrogen After Treatment	% NH_3 Reduction	Raw Water pH — 7.6
1.7 ppm	8 ppm	6.5:1	1.4 ppm	17%	Temp. Raw 50° F.—60° F.
1.7 ppm	13 ppm	8:1	0.01 ppm	99%	
1.7 ppm	19 ppm	11:1	0.01 ppm	99%	

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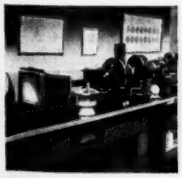

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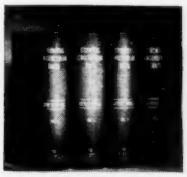

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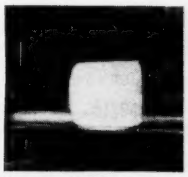

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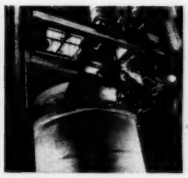

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ppm of soda ash was necessary. With these increases in softening chemicals the softening action was the same as in the absence of chlorine. The chlorination method for ammonia removal, therefore, does not interfere with the efficiency of softening; however, some adjustment in the dosages of softening chemicals is required.

Reactions 1 and 2 as presented above indicate that the mono-chloramine is formed when chlorine is added to water containing ammonia between pH values of 6.5 and 8.5. Reaction No. 3 is explained as being possible due to the aeration that takes place in the mixing tank. The remaining reactions postulated to take place through the feed of chlorine are as follows:

4—$2HCl + Ca(HCO_3)_2 \rightarrow CaCl_2 + 2CO_2 + 2H_2O$

5—$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

6—$Na_2CO_3 + CaCl_2 \rightarrow CaCO_3 + 2NaCl$

In Reaction 4, the hydrochloric acid (formed in Reaction 4) reacts immediately with the natural alkalinity of the raw water, forming a proportionate quantity of calcium chloride and liberating carbon dioxide. This quantity of carbon dioxide, if it reaches the softener, will require a proportionate quantity of calcium carbonate as shown by reaction five. Reaction 6 shows the necessity for an additional quantity of soda ash to react with the calcium chloride (produced in Reaction 4) forming the insoluble calcium carbonate.

The theoretical amounts of lime and soda ash required by the use of chlorine for ammonia removal may be subject to some variation; dependent upon the carbon dioxide lost by aeration, as in the mixing tank, or loss in the heating section of the softener. As stated previously, actual requirements were found to be 1.4 ppm of lime and 1.4 ppm of soda ash per ppm of chlorine employed.

1. Break-point chlorination will remove all but slight traces of ammonia.

2. Approximately 1.4 ppm of lime and 1.4 ppm soda ash are required per ppm chlorine to maintain the same lime-soda softener balance. With this change there is no interference with satisfactory softening.

3. No chlorine residual is imparted to the deaerated boiler feedwater.

4. The ammonia originally present in the steam and condensate system is gradually reduced by blowdown, steam and condensate leakage and wastage, and make-up from a source of water which is free of ammonia.

Allis-Chalmers Reports on 1946 Technical Progress

ALLIS-CHALMERS Mfg. Co. reports significant progress in development and design work on most of the company's highly diversified line of power generation, distribution and utilization products, despite a curtailment in actual production through most of 1946 due to labor difficulties, according to the firm's latest annual engineering *Review*.

Development work on a 10,000-kw gas turbine has progressed to a point where characteristics and performance of all its major elements have been determined, the *Review* reveals. This high efficiency unit will operate on the regeneration cycle, the air being cooled between stages in the air compressor and preheated from the turbine exhaust before entering the combustion chamber.

Recognizing the seriously slim safety margin between installed generating capacity and the nation's peak power loads, Allis-Chalmers has set as its primary objective completion of the maximum amount of new generating capacity in the shortest possible time. Meanwhile, it is apparent that avoiding actual power shortages calls for close cooperation between equipment manufacturers and the power generation industry, the *Review* declares.

Standardized Turbine Designs

Industry acceptance of standardized steam turbine designs newly developed by Allis-Chalmers in six sizes marked 1946 steam turbine advancement. Not only did the new designs meet a wide range of requirements, but attractive exterior lines symbolized progress which the power generation industry was now ready and anxious to record.

Of the six standardized design sizes, 11,500-, 15,000-, 20,000-kw and 30,000-kw units are single-cylinder, while 40,000 and 60,000-kw units are tandem-compound. The two smallest sizes are air-cooled, the larger sizes are hydrogen-cooled. Such features as 13 percent chrome blading, radial interstage seals, separate blade rings, top steam chests and solid couplings are provided to insure smooth efficient operation.

Large turbine generators were in record demand in 1946, the *Review* reports, with approximately 4 units ranging in size up to 80,000 kw in various stages of construction at Allis-Chalmers at the year's end. In new standardized hydrogen-cooled machines, a redesign of the coolers permits locating the cooler sections concentrically, instead of eccentrically, with respect to the stator core, resulting in an appreciable reduction in stator yoke diameter.

Condensers

Standardized surface ratings for all Allis-Chalmers steam condensers, adopted in 1946, will provide standard units to fit practically all central station, municipal or industrial plant requirements. Among larger standardized central station condensers installed or assembled last year were three 45,000-sq ft units and a 70,000-sq ft unit for Ohio stations, 20,000 and 25,000-sq ft units for installation in Texas, a 47,500-sq ft unit for Lousiana and a 35,000-sq ft unit for installation in Wisconsin.

Progress in Pumps

A trend toward the increased use of alloy steel casings in boiler feed pumps is reported by the *Review*. Also being evidenced is an increased use of vertical-shaft, column-type mixed flow pumps for condenser circulating service. Design work has been completed on 11 different sizes of these pumps, seven of which have been produced.

Power plant operators cooperated in furnishing data for analyses of steam turbine blade deposits by X-ray diffraction during the year and from this information a relationship between the temperature at the point of deposition and the compounds occurring in deposits has been found. The study is to be continued throughout 1947 and plants operating steam turbines at 350 psi pressure or higher are urged to submit samples together with pertinent information for which data sheets are available.

Hydraulic Turbines

The *Review* reports a large number of sizeable orders for hydraulic turbines, among which are three very large propeller-type runner, concrete spiral casing turbines for the War Department's St. Mary's Falls plant at the Soo.

The Idaho Power Co. placed turbine orders for two of their plants—one 12,000-hp, 124-ft-head unit for Upper Malad, and one 22,000-hp, 157-ft head unit for Lower Malad. Both of these plate steel spiral casing turbines have been in process of design with materials ordered for fabrication of the units during 1947.

Construction of a high vacuum laboratory for the company's engineering development division was begun in 1946. A few typical development projects assigned to the new laboratory include the analysis of surface structure in bearing materials with the electron microscope by means of the replica technique and investigation of radioactive materials useful to industry.

To make possible smaller, lighter transformers, Allis-Chalmers research also aims at better utilization of oriented steel properties through proper processing of raw stock. In another project, new types of enamel with thermal expansion coefficients to match those of various alloys are being developed.

To supply power for testing high power electronic tubes, a high voltage rectifier-inverter comprised of two 1,000-kw rectifier-inverter tanks each connected to a transformer, was recently placed in service. The unit has a combined rating of 2,000-kw at 24,000 v d-c with tanks connected in series and 12,000 v d-c when connected in parallel.

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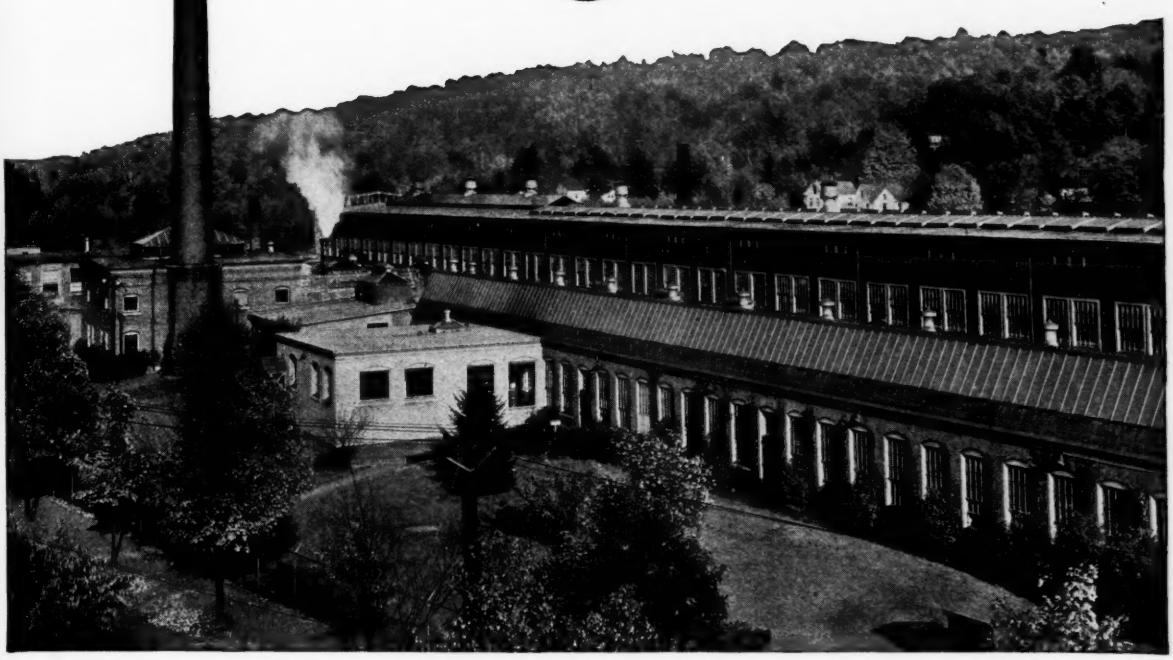

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P-11

WARREN PUMPS

Equipment Being Built for Coal-Fired Gas-Turbine Locomotives

PROGRESS in the design and testing of various components of gas-turbine locomotives has been so rapid and encouraging during the past year that the Locomotive Development Committee of Bituminous Coal Research, Inc., has now announced a complete schedule of work that will place revolutionary new coal fired locomotives on the rails for test in approximately 20 months. Immediate objective of the Committee, of which Roy B. White of the B & O Railroad is chairman, is to build two high-speed, double-ended locomotives of 3000 rail horsepower each, with 1000-mile non-stop fuel capacities. The gas-turbine power plants of the two engines will be different in design, but both will burn pulverized coal.

Formal orders have been placed with manufacturers for two gas turbine power plants. The Allis-Chalmers Mfg. Co., Milwaukee, Wis., is now building a plant with an axial compressor, arranged as shown in the drawing. The Elliott Co., Jeannette, Penna., is building a plant that will employ a two-stage centrifugal compressor. Locomotive designs are now being prepared by American Locomotive Co., New York and Baldwin Locomotive Works, Eddystone, Penna. and it is anticipated that the chassis will be be under construction within a short time.

It has also been announced that the Santa Fe Railway has ordered from the Baldwin Locomotive Works an oil-burning gas-turbine locomotive, which will employ an Elliott turbine similar to that previously ordered by the Locomotive Development Committee.

All technical details of research and development on these locomotives up to date have been in charge of John I. Yellott, Director of Research of LDC. He is now assisted by C. F. Kottcamp, who was in charge of the testing of the U. S. Navy's 3500-hp experimental unit. Reports on the progress of this work have appeared periodically in POWER PLANT ENGINEERING. Since many of the details apply equally to the design of gas-turbine power plants for stationary use, they are also referred to in the series of articles on the Gas Turbine Power Plant by Mr. Yellott now appearing serially in POWER PLANT ENGINEERING.

The gas-turbine locomotives now under development are of interest to power engineers, not so much from the railway point of view but from the fact that their principles of operation and much of their equipment, with slight modification and rearrangement, can be readily adapted to stationary practice.

The locomotives now under development are expected to burn less than 1 pound of coal per rail horsepower hour, use very little lubricating oil, require no water except for a train heating boiler, require less maintenance than steam or Diesel locomotives, and have an availability equal to that of Diesel.

Design and Operating Details

In the operation of these coal burning gas turbine locomotives, railroad coal will be used up to about 4 in. in size. This will be loaded into bunkers on the locomotives, then will be conveyed, dried and crushed, by compact devices incorporated in the coal handling system, to a 16-mesh top size. The coal will next be delivered to a coal pump, where it will be put under pressure, and then discharged directly to a coal atomizer, which will pulverize it. (See POWER PLANT ENGINEERING, December, 1945). The pulverized coal will then be air-delivered to the combustors, where it will be burned under pressure of 75 psi with air heated in regenerators to 600 F.

The gases will be freed of blade-wearing fly ash particles in a battery of Aerotec tubes, which are small, efficient cyclone separators. The combustion gases then enter the turbine at 1300 F at 75 psi. The turbine shaft drives the air compressor and the generator. Heat from the turbine exhaust gases is partially recovered in the regenerator mentioned above by transfer to the air used in combustion.

The power produced in the generator will be delivered to direct-current traction motors on the axles through a conventional control system. A mechanical transmission drive is also being considered for later development.

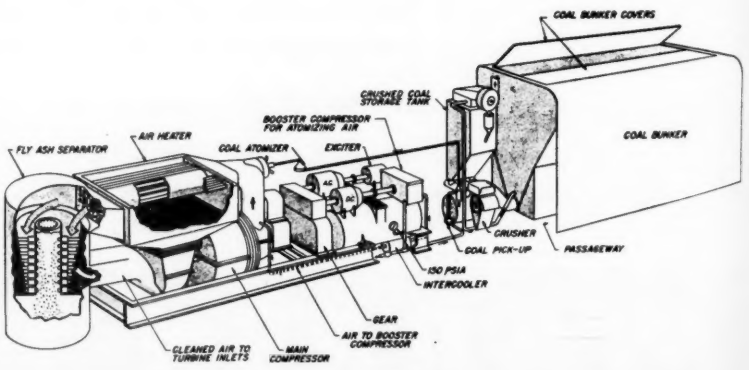
Testing Program to Continue

While the turbines are being built, tests will go forward on large-scale coal-handling and combustion equipment. Tests of a combustor burning 1000 lb of pulverized coal per hour at 100 psi pressure will be conducted at the plant of the American Locomotive Co., Dunkirk, N.Y., where preliminary work is already under way. Later, full-scale combustion tests at 3000 lb of coal per hour in one combustor will be carried out in Fontana, Calif., where 360,000 lb per hr of compressed air is available at 50 psi absolute pressure, at the plant of Kaiser Co., Inc. (See POWER PLANT ENGINEERING, December, 1945).

While small-scale tests will continue throughout the intervening months, enough laboratory work has been completed to permit construction and testing of full-size equipment. Various phases of the research program are being carried out at Johns Hopkins University, the Institute of Gas Technology, Battelle Memorial Institute, and Purdue University. A project on coal-weighing instrumentation has been successfully completed by the Southern Research Institute.

After construction of the turbine-generator units at the Elliott and Allis-Chalmers plants, they will first be tested for rating and performance with liquid fuel. Later, coal-handling and combustion equipment similar to that tested at Fontana will be set up at the Elliott and Allis-Chalmers plants for tests in conjunction with the turbine generators.

With the locomotive development program at mid-point, accomplishments may be summarized as follows: A coal atomizing and drying system has been worked out, a pulverized coal metering system is available and ready for application, pressurized combustion of coal studies forecast successful operation at the required rate. Fly ash removal from combustion gases can be accomplished to permit damage free operation of the gas turbine, and a coal-handling system is being designed for full-scale operation based upon satisfactory laboratory tests.



Arrangement of combustion and fly-ash removal equipment for coal-burning gas turbine locomotive

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2266

Boilers on Roof of 18-Story Building

HIGHEST installation of heating boilers ever made above ground took place recently when two steel heating boilers, with capacity of 24,290 sq ft of direct steam radiation each, were placed atop the 18-story Kirby Building in Dallas, Texas.

The Kirby Building originally was constructed adjacent to the Adolphus Hotel, which supplied both buildings with electricity and steam.

Recently, however, the electrical generating plant was displaced and the Kirby Building turned to public utilities for heating, electricity and water. The electricity and water requirements were met with no difficulty. But the heating problem was more complex.

Rental value of the Kirby Building basement was such that boilers could not be installed there, nor was it practical to construct a sub-basement.

Zumwalt and Vinther, consulting engineers of Dallas, decided that the roof was the only avaliable place to put the boilers. A penthouse was built on the roof to house the boilers and air-conditioning units, as shown in Fig. 2.

First choice for fuel in the Southwest is natural gas, second choice is oil; both could be piped to the roof of the 18-story structure without difficulty.

The greatest problem was hoisting the boilers, both in the initial installation and in case of possible future replacement. The engineers chose the Pacific boiler, which is designed so it can be disassembled into (1) base, (2) firebox, and (3) shell, and reassembled on the job without services of a welder and without a second shop or boiler insurance inspection.

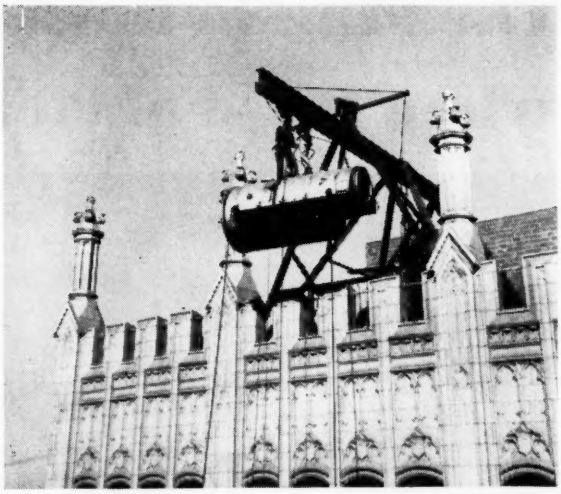

Fig. 1. Boiler shell landing safely on Kirby Building roof

These boilers are of the two-pass fire tube type, made by the Pacific Steel Boiler Division of U. S. Radiator Corp. Each boiler is designed for gas fuel and has a capacity of 24,290 sq ft of direct steam radiation. Each boiler has a heating surface of 1429 sq ft, and was built for 15 psi working pressure and in accordance with ASME Code. The boilers were set on firebrick flatways which were placed on top of a layer of 4-in. hollow tiles arranged end to end to permit passage of air.

The boilers each weigh approximately 16,000 lb, and are 13 ft long by 5 ft 6 in. wide, and 10 ft high. Largest single piece to be handled, the main shell of the boiler, weighs about 10,000 lb. The view in Fig. 1 shows how the boiler was hoisted.

Since the Kirby Building was constructed without a chimney and construction of one was impractical, each boiler was equipped with an induced draft fan. Each fan is designed to handle 3600 cfm of 500 F gases at 1 in. H_2O, and an outlet velocity of 2000 fpm. Each fan is driven through variable pitch V-belt drives by a 3-phase constant-speed squirrel cage motor.

Getting Condensate to Roof

A condensate pump in the basement returns condensate from the basement to the roof. It is of the turbine type, directly connected to a 5-hp motor, and is furnished with magnetic starter and hand-off automatic switch. The condensate pumps in the penthouse are of the vertical type with receiver, and were installed with top of basin 6 in. above the finished floor of the penthouse, with the receiver projecting into the attic. Each has a rating of 40,000 EDR and the two pumps are arranged as a duplex unit, with receivers cross-connected near the bottom.

The condensate pump in the basement starts and stops under control of a float switch installed on the side of a former air receiver converted to a condensate receiver. Condensate pumps in the penthouse are controlled from water-level control switches installed on the boilers. The wiring is arranged in such a way that the controls can be electrically switched to control either pump or pumps simultaneously.

In operation, the boilers can be filled by means of a manually controlled line. Level is maintained by the float switches on the boilers as long as water is available in the receiver. If sufficient condensate does not accumulate to satisfy the demands of the boilers, the water level in the receivers will fail until the float valve opens to supply the deficiency.

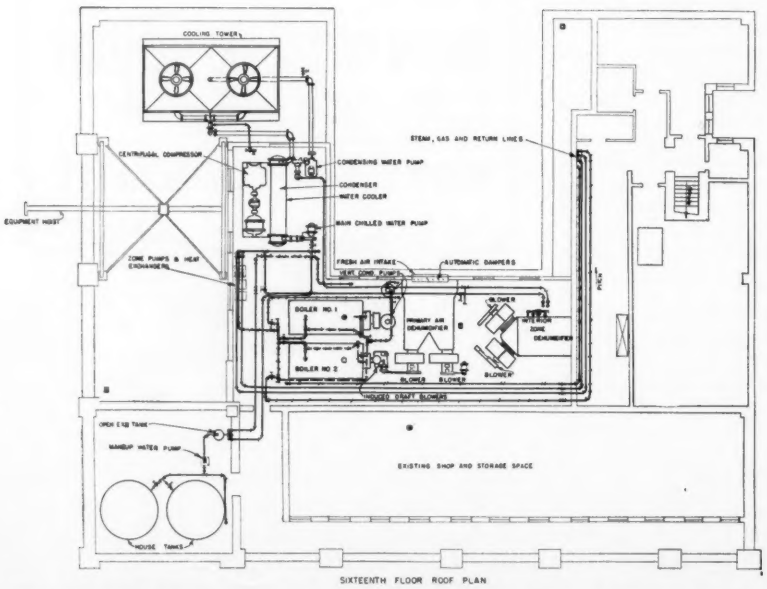

Fig. 2. General plant of penthouse on roof of Kirby Building, showing location of heating boilers, auxiliaries and air conditioning equipment

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TYPICAL W & T DE-SLIMING INSTALLATION

$11,000 a year from cooling water

A progressive midwestern power company has been using the W & T intermittent De-Sliming Process on condenser cooling water for over ten years. Here's what they report for a typical year:

Fuel saving	$9900.00
Labor saving	4000.00
Gross saving	$13900.00
Operating and depreciation cost	$2900.00
NET SAVING	$11000.00

In addition, they have eliminated the disagreeable job of plug cleaning, have all units always available at maximum capacity and make more efficient use of existing cooling water supplies without additional expense.

W & T Field Engineers will be glad to discuss the application of chlorination through the Intermittent De-Sliming Process to your condensers and heat exchange equipment. Call on them freely or write for technical information today.

CD-25

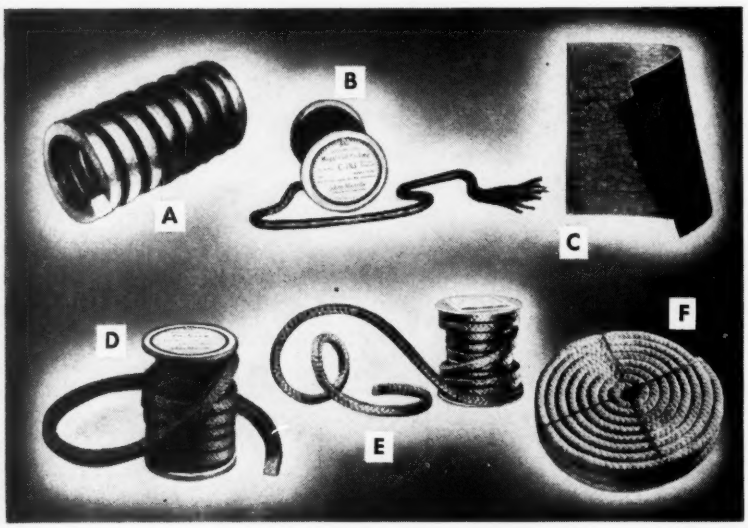
WALLACE & TIERNAN
PRODUCTS, INC.
BELLEVILLE 9 NEW JERSEY

The sign of a GOOD PACKING

JOHNS-MANVILLE JM PRODUCTS

The J-M Trade Mark is and long has been a familiar sign throughout industry of an effective seal . . . *the sign of a packing that means lower maintenance costs and less shutdown time.*

Here are 6 typical Johns-Manville Packings designed to meet a wide range of service conditions.



A. J-M Kearsarge. A long-wearing rod and plunger packing with a unique folded construction that forms a reservoir for the preserving lubricant.

B. J-M Mogul Packing. For general utility service . . . braided and twisted styles lubricated inside and out for longer life.

C. J-M Service Sheet. A tough, pliable, resilient gasket material with a wide range of applications. Industry's No. 1 sheet packing.

D. J-M Interlocked. A rugged, durable, square-braided packing, without plaits or jackets to loosen . . . for reciprocating and rotating rods.

E. J-M Centripac. Designed especially for packing centrifugal pumps and other rotating and oscillating rods and shafts.

F. J-M Navalon. A newly developed packing for cold liquid service. Contains and retains more lubricant in service; long-wearing, abrasive-free.

See your J-M Packing Distributor or write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville PACKINGS & GASKETS

PLACING THE STEAM GENERATOR IN OPERATION

(*Continued from page 111*)

ice. The service engineer spends that evening in repeating instructions to the night operator. The day's events have stirred up these men's interest in operation and the questions come thick and fast. A tired service engineer leaves the plant late that night realizing that an emergency outage can do more to quicken the interest of the operators in routine instructions than any other single method which could be employed.

Operation continues to be satisfactory for the next few weeks and the operating crews after a few minor troubles are getting the feel of the equipment and they can tell by the sounds of the plant how each piece of equipment is performing. Subconsciously they seem to know when the equipment is performing correctly and this knowledge proves to be an invaluable aid in avoiding serious trouble on several occasions. A third and then a fourth operating crew is brought into the new plant and trained and the operating shifts are reduced to eight hours a day. The fourth operating crew is used as a relief crew and is available to replace men on their days off.

The service engineer slowly withdraws from the operating picture and spends his time checking boiler performance and gathering test data on the unit. As the days pass his only concern is a desire to shut the boiler unit down in order to seal off some of the air leaks which are impossible to reach while the unit is in operation. He realizes that such a reason for taking the unit out of service would not be acceptable to the plant officials and he does not suggest a shut down for this reason. Finally a day arrives however, when the turbine engineer expresses a desire to shut down as he wishes to make some minor repairs to the turbine governor. It also develops that the electricians wish to inspect and check the generator as well as some of the new switchgear. The various requests are quietly passed along to the plant officials and strangely enough a shutdown of the new plant is arranged.

The First Outage

After six weeks of continuous operation, permission is finally given for the first scheduled outage. Each of the individuals concerned is satisfied even though the outage is limited to a three-day period over a week-end. There is a rush to arrange for the necessary inspections and repair work which is to be done during this outage. The day of the outage is presently at hand and for three days the work of inspecting and making repairs is carried forward with feverish activity. The boiler erection crews complete their work on the boiler unit during this outage and the unit is soon ready for service. The other crews also complete their work on

schedule and a general feeling of satisfaction exists as all equipment is returned to service in the best possible operating condition.

With the outage complete the operating crews find that the normal hum and song of the equipment is a welcome sound. To them it is as if an old friend has returned after a long absence. Many other friends are leaving the plant. The boiler erection crew with their work completed are gathering up their equipment and most of the men are gone by the time the boiler unit is returned to service. The head erector and a few men remain for a day after the unit is returned to service but these men too leave after finding that their work is satisfactory. The insulating crews remain for several weeks to finish covering piping but even this work is quickly finished and the cleanup crews followed by the painters begin to appear in the next few weeks.

The boiler unit becomes bright and shiny in its new coat of paint and the whole plant asumes a clean orderly appearance. The service engineer as he notes the daily progress of the cleanup crews and painters, realizes that his job is nearly complete. He continues his test work and the accumulation of data on the boiler unit and soon this work is also completed. The boiler unit seems aware of the lessened confusion and activity surrounding it and performs splendidly. The operators listen to its steady song or purr and as the days pass begin to regard the huge metal giant as a powerful friend. Some of these men are even heard referring to the unit as a nice baby or the old lady and the tone of their voices indicates affection for the huge piece of equipment which has assumed so important a part in their daily lives. It is true that minor troubles are encountered which change their references to the unit to stronger terms than those given above, but when the sweat is washed away and the unit continues day after day to give satisfactory service, these words are retracted and the unit again becomes affectionately "The old lady."

The day finally arrives when the service engineer, his work complete, bids the operators good-by. The huge metal giant continues its song unmindful of his leaving but the operators all seem to regret the loss of a friend. They all ask him to come back if possible, even if it is only for a visit and he promises that he will stop in if he is ever in that district again. As he leaves the plant he is proud of the boiler unit and its song continues in his mind even after he leaves the building. The huge metal giant has started a long and useful life with an operating crew who are proud to be part of the many hours of faithful continuous service which the new unit will establish for the record books. The service engineer is therefore satisfied and he leaves the plant confident that the new boiler unit will continue to give many hours of safe, reliable and continuous performance in actual operation.

The sign of a GOOD PACKING DISTRIBUTOR

WHEN you need a packing—you'll find, as thousands of others have, that the sign, Authorized Distributor—Johns-Manville Packings—means the right packing for your job . . . and a man who is ready and able to help solve your particular packing problem.

Your J-M Distributor is one of 400 Industrial Distributors who are located in important cities throughout the country and who stock Johns-Manville Packing in many forms and styles. Besides being a convenient supply depot for packing, he is also headquarters for many other industrial supplies. Wherever there's a need for an essential part or tool or material, you can count on him for prompt, efficient service at all times.

Packings For Every Service are available through your J-M Distributor. See him about your Packing needs.

Your **Johns-Manville PACKING DISTRIBUTOR**

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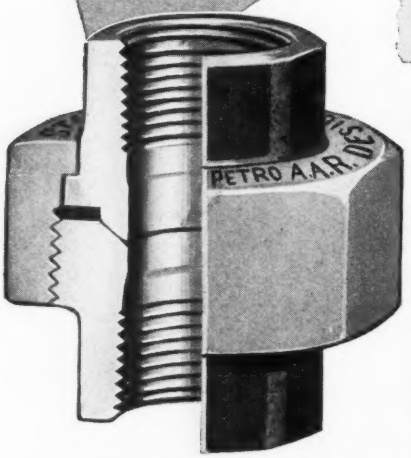
ENDURANCE

in FORGED STEEL UNIONS



SIZES ⅛" TO 3"

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AMERICA'S MOST UNIVERSALLY USED UNION

PETRO unions have integral steel to steel seats. Made to A. A. R. design. 600 lbs. S.W.P.-2000 lbs. C.W.P. Extra heavy ends and nut with nut threads that are permanently lubricated. The seats are machined and cold rolled.

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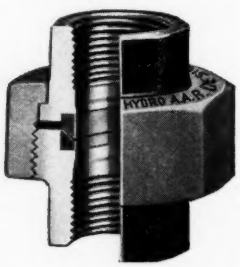
Pressures from a vacuum to 3000 lbs.: Temperatures from 100° below zero F. to 1000° above zero F.: On Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and any service in which Steel or Wrought Iron Pipe is Used.

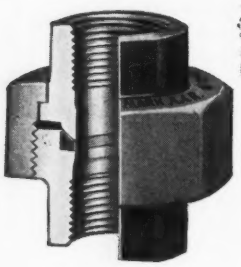
Hydro

THE ONLY FORGED STEEL UNION WITH TWO BRONZE SEATS

Made to A. A. R. design. 600 lbs. S.W.P.-2000 lbs. C. W. P. HYDRO unions have extra heavy ends and nut, with the nut threads permanently lubricated. The bronze seats are completely fused to the steel and are then machined and cold rolled.



SIZES ¼" TO 3"



SIZES ¼" TO 3"

Mark A.A.R.

AMERICA'S FIRST STEEL UNION

The MARK A. A. R. unions have bronze to steel seats. Made to A. A. R. specifications. 600 lbs. S. W. P.-2000 lbs. C. W. P. MARK A. A. R. unions have extra heavy ends and nut with the nut threads permanently lubricated. The bronze seat is completely fused to the steel and then machined and cold rolled.

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ORIGINATORS AND PIONEERS OF FORGED STEEL UNIONS

CLAYTON MARK & COMPANY

1900 DEMPSTER STREET • EVANSTON, ILLINOIS

GAS TURBINES TO BACK UP SWISS HYDRO IN WINTER

IN ALL the Swiss rivers their water flow is lowest during the winter months, naturally because of freezing weather in the higher mountain regions. Thus the power output of the many plants along these rivers is at a minimum when the load demand is at its peak. To make up for this shortage many water storage basins with dams have been built in the mountains. These artificial lakes are filled during spring and summer when the snow melts and are drained through high-head power stations during the winter months, to supplement the reduced output of the river stations.

These dams and high head stations have however, several serious drawbacks; they are expensive, take many years to build and are, as a rule, rather far away from load centers, thus requiring long and expensive transmission lines. Also, desirable sites for such artificial lakes are getting scarcer as time goes on and in addition there have lately been several rather dry years, especially 1946. As the load keeps growing and the war made it impossible to start large engineering projects, the situation reached a critical point last summer. Thus the decision was reached to supplement the winter power supply by two gas turbine units, of 13,000 and 27,000 kw respectively, according to Paul R. Sidler, president, Brown Bover, Corp., New York, in his paper before the Midwest Power Conference, April 12, 1947.

These sets will only operate during 4 or 5 months from November to March, when the average air temperature is around 41 F. It is a well-known fact that the output and the efficiency of a gas turbine increase when the air temperature goes down. When the air temperature is reduced from, say, 70 F to 40 F, the power of a given gas turbine is increased by 30 per cent and its efficiency by about 5 per cent.

The gas turbine sets built for Filaret in Rumania (See POWER PLANT ENGINEERING, March, 1947, page 124, Fig. 2) and again for Lima, Peru have a rating of 10,000 kw with an air temperature around 70 F, and some comfortable safety margin. With 40 F air, this frame size will readily produce 13,000 kw.

The Lima unit has a two-stage arrangement with heat exchanger for high efficiency and base-load operation. It is at the same time the design of the 13,000-kw unit now being built for the Swiss Power Plant and due to go into service on November 1, 1947. The guaranteed full load efficiency is 30.5 per cent.

The capacity of 27,000 kw will be obtained by doubling these machines and by taking advantage of the improved efficiency of the larger frame size and, to a certain degree, also of the safety margin. This set will have a full load efficiency of 34 per cent referred to generator terminals and is scheduled to go into operation on November 1, 1948.

First, **INDUSTRIAL TRUCKS . . .**

Then, **PALLETIZED UNIT LOADS . . .**

Now, **STANDARDIZED**

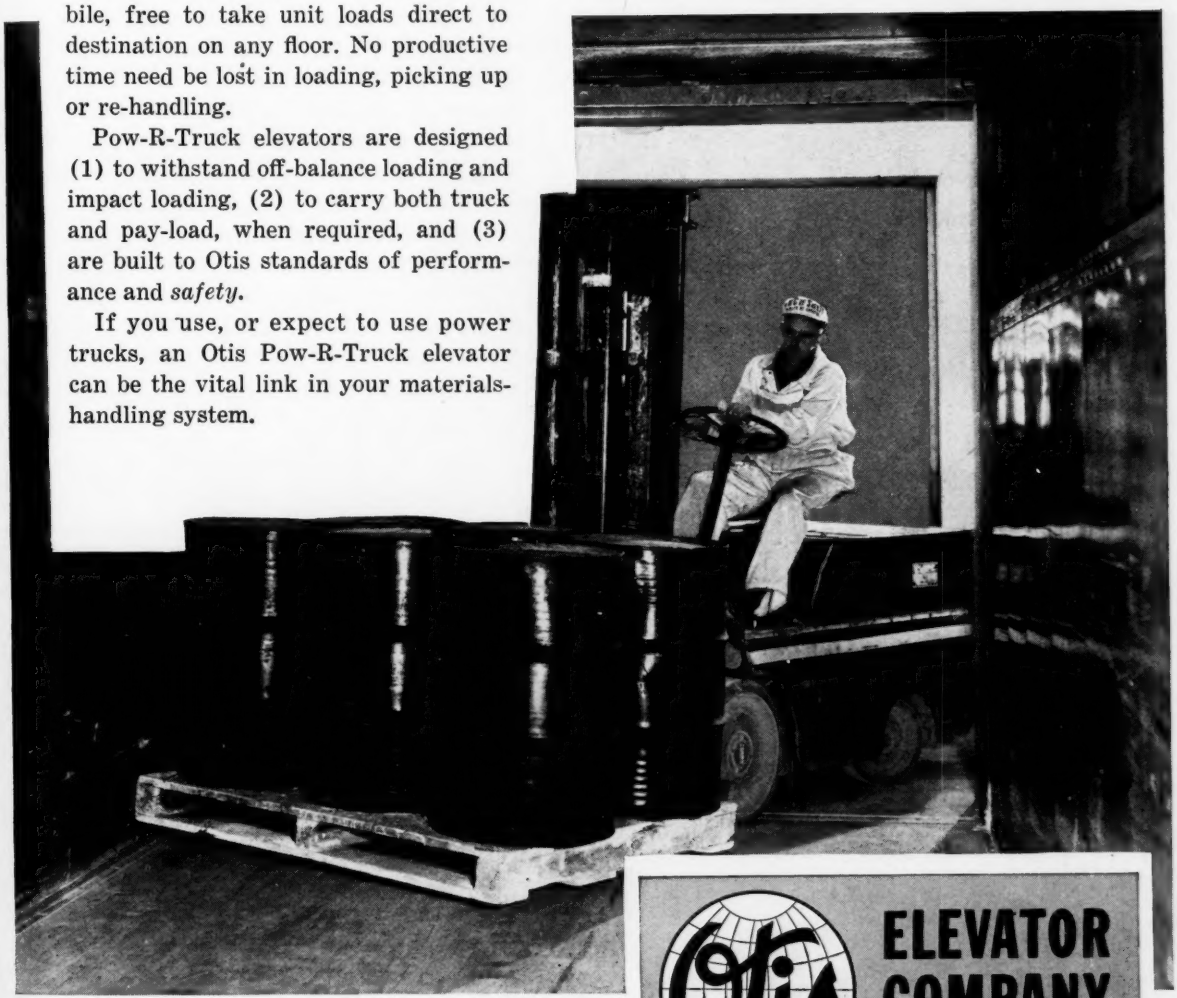
POW-R-TRUCK ELEVATORS!

This latest addition to the Otis line of standardized freight elevators—previously available only as a custom-built "special"—adds *floor-to-floor travel* to the many other time- and labor-saving advantages of industrial trucks . . . effectively increasing their usability.

With a Pow-R-Truck elevator an industrial truck becomes *completely* mobile, free to take unit loads direct to destination on any floor. No productive time need be lost in loading, picking up or re-handling.

Pow-R-Truck elevators are designed (1) to withstand off-balance loading and impact loading, (2) to carry both truck and pay-load, when required, and (3) are built to Otis standards of performance and *safety.*

If you use, or expect to use power trucks, an Otis Pow-R-Truck elevator can be the vital link in your materials-handling system.



For illustrated folder please address Otis Elevator Company, 260 Eleventh Ave., New York 1, N. Y.

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STEAM ENGINE
By-Product Power
1 POWER for your stokers, generators, pumps, compressors
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And both accomplished by skillfully engineered use of the same steam. This is Troy-Engberg By-Product Power at work.

Use the modern Troy-Engberg Steam Engine to drive stokers, blowers, fans, compressors, mixers, generators and pumps—THEN use the exhaust from the engine for your processing or heating, or both.

Cut Power Costs by putting your steam fully to WORK. Write us for detailed information on applying Troy-Engberg By-Product Power to your plant.

Send for Bulletin 306

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TROY-ENGBERG

STEAM ENGINES • GENERATING SETS • GENERATORS

COMING EVENTS

ASHVE—Semi-Annual meeting of the American Society of Heating & Ventilating Engineers; to be held June 2 through 4 in Coronado, California with headquarters at the Hotel del Coronado.

AIEE—Summer General Meeting of the American Institute of Electrical Engineers; to be held in Montreal, Quebec, Can., June 9 through 13.

Stoker Manufacturers—Annual meeting of the Stoker Manufacturers' Association to be held June 16, 17 and 18; headquarters to be at Lookout Mountain Hotel, Lookout Mountain, Tenn.

ASME—Semi-Annual Meeting of the American Society of Mechanical Engineers; to be held in Chicago, June 16 through 19, with headquarters at the Hotel Stevens.

National District Heating Association—38th Annual Meeting of the NDHA; to be held June 16 through 19 with headquarters at the Ambassador Hotel, Atlantic City, N.J.

ASTM—1947 Annual Meeting; to be held in Atlantic City, June 16 through 20, with headquarters at Chalfonte-Haddon Hall.

ASME—Fall Meeting of American Society of Mechanical Engineers; to be held in Salt Lake City, September 1 through 4, with headquarters at the Hotel Utah.

NAPE—National Association of Power Engineers, Annual Show and Convention; to be held August 25 through 28 with headquarters at Hotel Statler.

Instrument Society—Instrument Society of America annual meeting; to be held the week of September 8, 1947, with headquarters at the Stevens Hotel, Chicago.

Instrumentation Conference—Instrumentation Conference and Exhibit for 1947; to be held the week of September 8, with headquarters at the Stevens Hotel, Chicago.

ASME—Fuels Division Meeting of the American Society of Mechanical Engineers; to be held, October 6 through 8, in Houston, Texas. (Headquarters not yet announced.)

Hydraulics—Third Annual Meeting of the National Conference on Industrial Hydraulics (formerly the Hydraulic Machinery Conference); to be held October 16 and 17 in Chicago with headquarters at the Hotel Continental.

Power Exposition—Midwest Engineering and Power Exposition, "The Chicago Power Show," to be held November 15 through 20 at the Chicago Coliseum.

ASME—Annual Meeting of the American Society of Mechanical Engineers; to be held in either New York City or Atlantic City, N.J., December 2 through 5. Headquarters Chalfonte-Haddon Hall.

Refrigeration and Air Conditioning Exposition—Fifth All-Industry Exposition; to be held January 26 through 29, 1948 with headquarters at Cleveland Public Auditorium, Cleveland, Ohio.

NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS

THE THIRD ANNUAL meeting of the National Conference on Industrial Hydraulics (formerly the Hydraulic Machinery Conference) will be held on October 16 and 17, 1947, at the Hotel Continental in Chicago, Illinois.

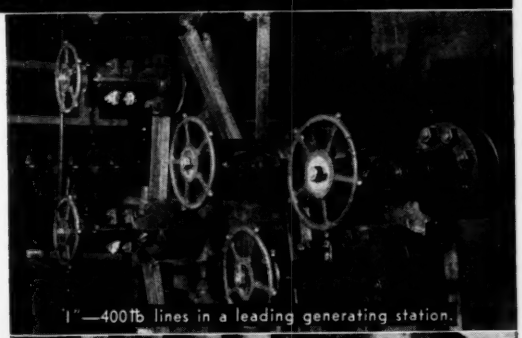
This conference is sponsored by Armour Research Foundation and the Graduate School of Illinois Institute of Technology in cooperation with the Western Society of Engineers and the Chicago sections of the Society of Automotive Engineers, American Society of Civil Engineers, and the American Society of Mechanical Engineers.

The subjects of the four half day sessions will be "Cavitation" . . . "Industrial Application of Hydraulics" . . . "Automotive Fluid Transmissions" . . . and "Hydraulic Controls."

The dinner address on the evening of the 17th will be delivered by a nationally outstanding engineer and scientist.

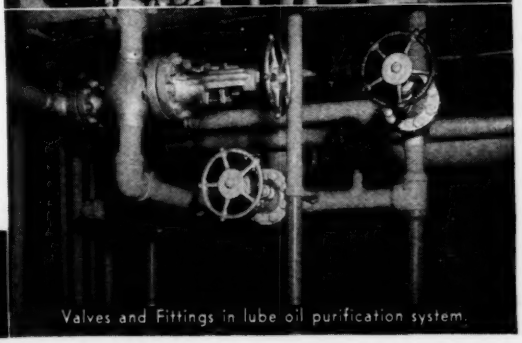
SPECIFY Vogt

DROP FORGED STEEL VALVES, FITTINGS & FLANGES FOR STEAM GENERATING PLANTS



1"—400lb lines in a leading generating station.

1½"—1500lb high pressure drip lines.



Valves and Fittings in lube oil purification system.

SAFE and SURE control of vapors and liquids at high pressures and high temperatures in modern steam generating plants is dependent on piping materials having an inherent "plus" of strength and toughness. *Drop forged steel* Valves, Fittings, and Flanges made by Vogt play a vital part in the smooth, efficient operations of leading power plants.

Catalog F-8 is the drop forged steel Valves and Fittings Blue Book.

HENRY VOGT MACHINE CO., INC.
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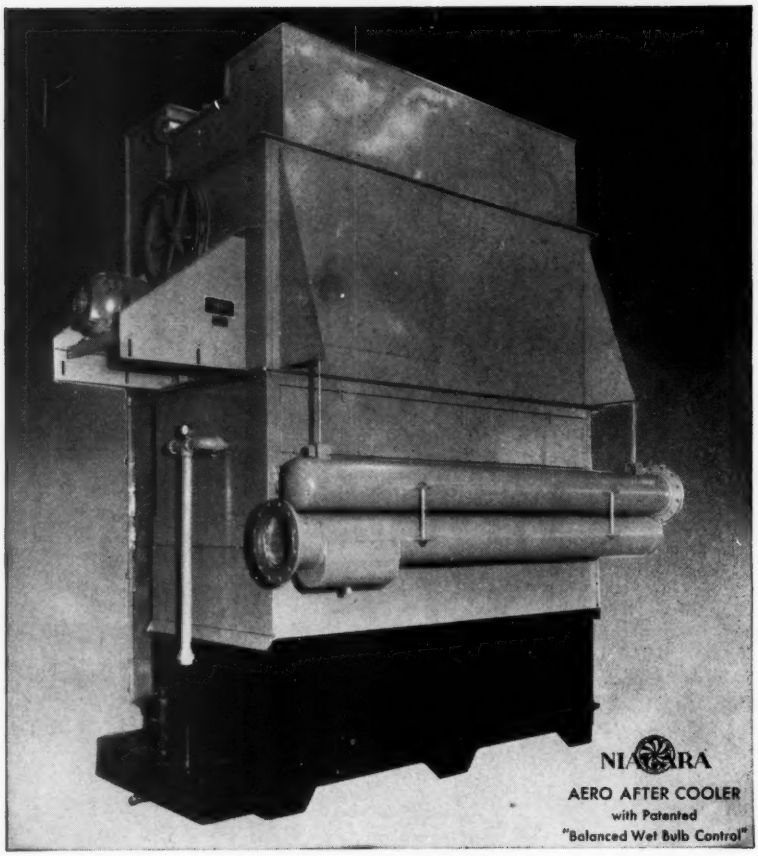

Save expensive "wear out" of air tools

● Water in compressed air lines is more than a nuisance; its cost is thousands of dollars yearly in worn-out tools and equipment, or broken air tools caused by water hammer, abrasion and washed-out lubricants.

Protect your air tools and compressed air processes with drier compressed air . . . using the NIAGARA AERO AFTER COOLER. Based on the evaporative cooling principle, it always keep the air in compressed air lines below the relative surrounding temperature, preventing condensation and, under the least favorable conditions, provides air with one-third to one-half the moisture content of water-cooled air.

Water savings will pay for the installation. Write for Bulletin 98-PP.

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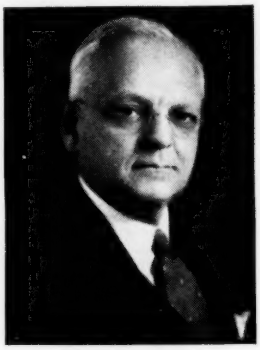
Obituaries

HARRY C. BEAVER

HARRY C. BEAVER, Vice-Chairman of the Board of Directors and formerly President of the Worthington Pump & Machinery Corp., Harrison, N.J., died suddenly in New York on April 2nd.

Harry C. Beaver was born in McAllisterville, Pa., August 13th, 1876, the son of Spencer and Minerva Beasor Beaver. He attended Juniata college, Huntingdon, Pa.,



Martins Business School, Pittsburgh, and the Marquette University Law School. Mr. Beaver's first business position was with the Pennsylvania Railroad where for several years he was connected with the motive power department of Pittsburgh. He later joined the sales department of Westinghouse Electric Manufacturing Co. at East Pittsburgh, Pa. In 1904 he joined the Allis-Chalmers Manufacturing Co. serving first in capacity of Assistant to the General Sales Manager, later as Assistant to the President, still later as General Manager of the Norwood, Ohio Electrical Works of the Allis-Chalmers Co.

In 1912 he became associated with the original Stevens-Duryea Co. at Springfield, Mass. as Vice President in Charge of Sales and Advertising, in addition to directing the manufacture of Stevens-Duryea bodies at East Springfield. He joined Rolls-Royce of America, Inc., Springfield, Mass. as Treasurer in 1919. He was subsequently elected Vice-President of this organization and placed in charge of Engineering and Manufacturing.

Mr. Beaver joined the Worthington Pump & Machinery Corp. in February 1931 as Vice-President in Charge of Sales as well as a Director and member of the Board and Executive Committee. He was elected President of the Worthington organization in September 1931. He served in this capacity until December 1944, his direction being responsible for notable growth of the Worthington organization in the 30's through acquisition of the interests of such companies as the Metal Weld, Inc., the Gilman Manufacturing Co., the Carbondale Machine Co., the Gamon-Meter Co., and the Moore-Steam Turbine Corp. This same guidance was responsible for the more recent acquisition of the Worthington subsidiaries, the Ransome Machinery Co. and the Electric Machinery Manufacturing Co.

Mr. Beaver was elected Vice-Chairman of the Board of Directors in December 1944.

STYLE NO. 703

R/M tadpole tape is designed to provide a tight seal on furnace doors and in applications where heat-resistance is important, but flange pressure is not great.

The packing consists of a soft core of asbestos with a wire-inserted asbestos cloth folded over the exterior. It is impregnated with a special binder, selected for its heat-resisting quality, and the typical tadpole-like cross-section is the result of the cloth extending to one side. This forms a flange for riveting or securing the gasket, yet leaves the round portion as a cushion upon which the door or cover closes.

Whatever your packing requirements, your authorized R/M distributor can supply the one R/M packing that is specially engineered to do the job.

RAYBESTOS R M MANHATTAN

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ASBESTOS TEXTILE & PACKING DIVISION

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It's "Packed with Satisfaction" when you use R/M

5-1-3

THIS tank holds water — 600,000 gallons — but not one drop has touched the steel. APEXIOR NUMBER 3 keeps it as dry today as before it went into service — guards it not only below the fluctuating water line, but above it, against moisture condensation.

APEXIORize cold-water-exposed metal in new tanks or old and you add a surface secure against corrosive attack, for water — fresh, salt, acid– or alkali—contaminated — can't get through to the steel beneath.

And because APEXIOR stands up to the toughest of tasks . . . even goes to sea on the submerged stern areas of ships . . . you can buy its protection at minimum upkeep cost.

APEXIOR NUMBER 3 is recommended not only for drinking and other cold-water tanks, but for refrigerant condenser tubes, air conditioning equipment, sprinkler systems . . . wherever sheltered metal is exposed to water to 140°F. (125°F. under rapid flow), or dry heat to 475°F.

Write for Industrial Bulletin to
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HYDE PARK BOSTON

NEWS *from* THE FIELD

150,000 KW PLANT IN OKLAHOMA CITY

EXPENDITURE OF $9,000,000 for a new 150,000-kw electric-generating plant 10 miles west of Oklahoma City, Oklahoma on the North Canadian River has been authorized for prompt construction by Oklahoma Gas & Electric Co.

Preliminary plans call for three generating units each of 50,000 kw capacity. The first generating unit and the plant will cost $6,000,000 with subsequent additions costing another $3,000,000. Westinghouse Electric Corp. has scheduled production of the first generating unit which is expected to be in service in 1950. The plant will be the largest generating facility in the Southwest, according to George Ade Davis, president of Oklahoma Gas & Electric who said last week that indicated growth of industry and population in the company's service territory required construction of the new units. The company serves approximately 200,000 customers in Oklahoma and Arkansas.

When the complete plant is in operation within the next 4 or 5 years, coal consumption will be 36 cars daily. The plant site is adjacent to the Rock Island Railroad Co. trackage.

GENERATORS FOR KORTES POWER PLANT ORDERED

THREE 12,000-kw generators for the Kortes Power Plant have been ordered by the Bureau of Reclamation. The contract for the generators was awarded to the Elliott Co. of Jeannette, Pa.

The Kortes Dam and Power Plant now under construction on the North Platte River about 60 miles southwest of Casper, Wyoming, comprise the Kortes Unit of the comprehensive Missouri River Basin development and was the first Bureau of Reclamation unit of the Missouri Basin project to be put under construction.

CHEMICAL INDUSTRIES EXPOSITION IN DECEMBER

ANNOUNCEMENT has been made of the 21st Exposition of Chemical Industries to be held the first week in December.

As heretofore, the display will combine chemicals and chemical products with all manner of equipment employed in chemical manufacture and by the processing industries. Because chemical ingredients and chemical process steps are almost universally employed, even in mechanical industries, few lines of activity are outside its scope.

Looking forward to the more complete liberation of industries from the yoke of wartime restrictions, manufacturers of both chemical products and processing equipment anticipate many innovations, resulting from development work, which has been in the laboratory since the pre-war period.

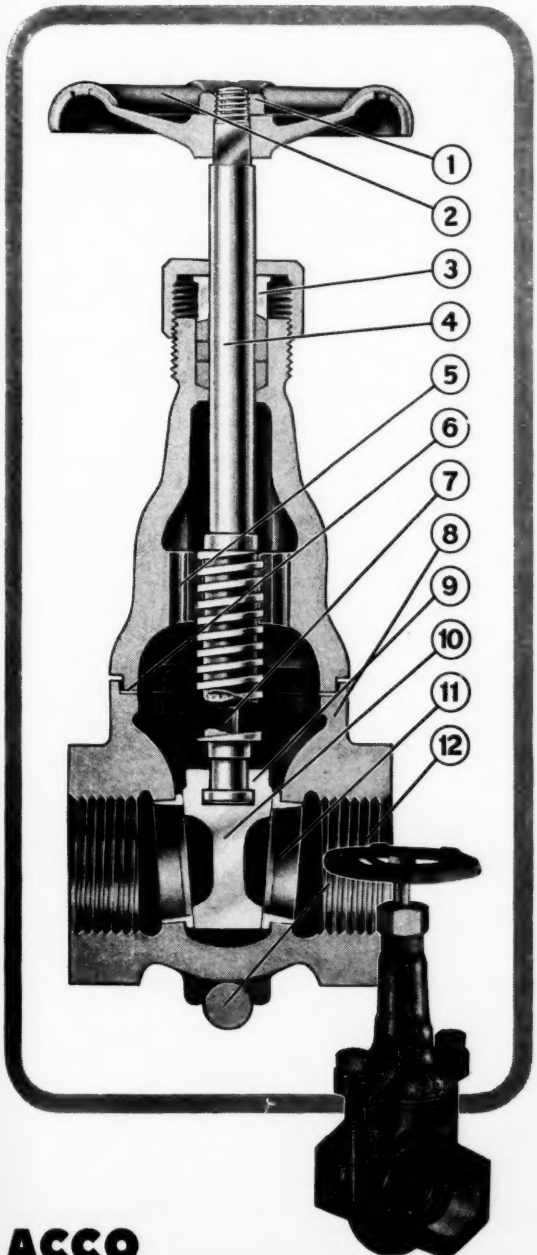
ATLANTIC CITY SITE OF ASME's 68TH ANNUAL MEETING

THE 1947 ANNUAL Meeting of The American Society of Mechanical Engineers will be held in Atlantic City, N.J., December 1-5, it was announced recently.

The Chalfonte and Haddon Hall will be the Atlantic City headquarters hotels. They have guaranteed 2,700 rooms for the meeting. Usually the attendance totals about 6,000 but it is expected to exceed that figure greatly this year. Some 200 engineers, scientists and industrialists take part in the program consisting of five days of continuous technical day and evening sessions.

The adoption of a theme for the year's series of meetings also was announced by the Society as follows: "The Engineers' Responsibility in Increasing National Productivity."

TODAY'S CLIP GATE VALVE BY READING-PRATT & CADY



Quick cleanout a *plus* feature of this good, tight, sturdy gate valve. Made of close-grained Hi-Test Gray Iron—50% stronger than ordinary iron.

1. Heavy wheel nut
2. Kool-grip malleable iron ventilated hand-wheel
3. Deep stuffing box with follower. Can be packed under pressure
4. Stem gray iron or bronze rod stock. Bronze bushing cast in
5. Full, adequate bonnet drain prevents possible trouble from freezing in outside installations
6. Male and female bonnet joint with asbestos gasket
7. Fully-machined wedge guides in body
8. Body and bonnet of close-grained Hi-Test Gray Iron—50% stronger than ordinary iron
9. Horseshoe type slip-on connection
10. Heavy cast I-beam wedge—reversible and renewable. Wedge rises above flow when open
11. Rolled-in seat ring (in bronze-mounted type)
12. Full U-bolt in closed bolt holes. Held in place by 3 sets of lugs on body

All iron or iron body, bronze mounted. Sizes ½" to 3". Rated 150# steam, 250# O.W.G. Ask your Reading-Pratt & Cady Distributor about Clip Gate Valves. Distributors in principal cities.

ACCO

Reading, Pa. • Atlanta • Baltimore • Boston • Chicago • Denver • Detroit • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • Portland, Ore. • San Francisco • Bridgeport, Conn.

READING-PRATT & CADY DIVISION
AMERICAN CHAIN & CABLE

TRADE MARK

Delivers the
RIGHT AMOUNT
of boiler feed WHENEVER NEEDED

With a Henszey Boiler Feed Regulator controlling the "life line" to your boiler, you help avoid burned out tubes, cracked headers, or even the serious explosions that can result from low water levels.

HENSZEY Boiler Feed REGULATORS

also guard against high water hazards by maintaining proper boiler water levels continuously, automatically, accurately under all conditions. These compact, self contained units go right into the line without additional supports. Once installed, they need no further attention — nothing to get out of order — nothing to rust. Made for pressures up to 600 lbs. and in sizes up to 4 inches. Now is the time to get more facts on low cost, accurate boiler level control. Send for bulletin or contact your nearest Henszey representative.

HENSZEY CO. Dept. C6, Watertown, Wisconsin

HENSZEY

BOILER FEED REGULATORS

Continuous Blowdown • Distillation Systems • Heat Exchangers
Feed Water Meters • Flow Indicators • Proportioning Valves
also MILK EVAPORATORS and PRE-HEATERS

BEARING MANUFACTURERS IDENTIFICATION PLAN

A STANDARDIZED numbering system for ball and roller bearing dimensions was presented recently to the American Standards Association by the Anti-Friction Bearing Manufacturers Assn.

The new code, presented by H. O. Smith, executive secretary of the Association, calls for a common means of identifying types, sizes, tolerances, modification of internal design and lubrication of standard ball and roller bearings to meet all the requirements of users. This new identification system, he pointed out, utilizes a combination of figures and letters alternately and is flexible enough to take care of future changes in design, tolerances, lubricants and separator materials and is semi-descriptive rather than a dead code.

KRUG APPROVES COLUMBIA RIVER DEVELOPMENT

SECRETARY of the Interior J. A. Krug recently announced approval of a report on a Departmental plan, sponsored by the Bureau of Reclamation, for comprehensive development of the Columbia River Basin in the Pacific Northwest. Embracing 238 projects, the plan charts developments for many decades. Eleven projects are singled out for authorization now to meet the earlier needs of the region.

If authorized by the Congress, the plan ultimately will benefit 5,360,000 acres of land, Secretary Krug explained. This will double the area now under irrigation in the Basin, and provide supplemental water to other land. Hydroelectric power capacity in the Basin upon completion of the plan, would be increased five-fold through new installations with capacity of 10½ million kilowatts. Truly multiple in purpose, the plan entails essential provisions for flood control, navigation improvements, fish and wildlife conservation, silt control, and pollution abatement.

PIPE FITTINGS PRACTICE

A PROPOSED revision of Simplified Practice Recommendation R185-42, Pipe Fittings, has been developed in cooperation with manufacturers of these fittings, and the Division of Simplified Practice of the National Bureau of Standards has mailed copies to all interests for approval or comment or both.

The original recommendation became effective January 1, 1942, and subsequently served as the basis for mandatory orders issued by the War Production Board. Following revocation of the last of these orders, the industry, in cooperation with the Division of Simplified Practice, drafted a revision, the purpose of which is to retain on a voluntary basis a standard of practice for these products.

The revision applies to Gray Cast Iron, Malleable Iron and Brass or Bronze Fittings. Fittings to which the recommendation does not apply are listed. As finally adjusted, the proposed revision now includes a comprehensive group of fittings required for sprinkler systems, in addition to the regular lines for other purposes. The section dealing with Brass or Bronze Fittings has been adjusted to provide for sectional, as well as general, needs.

OHIO EDISON ANNOUNCES CHANGES

MALCOLM W. SMITH, superintendent of electrical construction for Ohio Edison Co. for the past nine years, has been promoted to the newly created position of Superintendent of Production and Transmission Construction.

The announcement was made by Frank W. Funk, chief engineer of the Company, who also announced that Alfred L. Richmond, superintendent of electrical operations, will take on the additional duties of maintenance of all electrical equipment installed in operating stations and substations.

In his new assignment Mr. Smith will superintend construction of new or proposed projects, involving generating plants, substations, transmission facilities, steam heating

Investigate the SAVINGS you can make with Skinner

"UNIVERSAL UNAFLOW" STEAM ENGINES for . . .

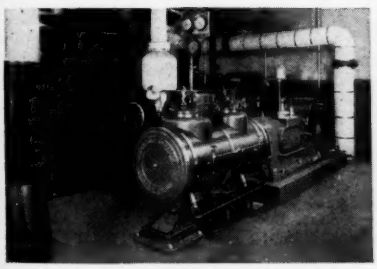
SKINNER "Universal Unaflow" Steam Engines are probably best known for their ability to generate electric power more economically than it can be purchased or produced by any other prime mover. They are serving in widely diversified industrial and institutional fields.

In other applications they are effecting equally important savings in driving blowers, compressors, refrigeration equipment, pumps, lineshafts, and other loads, by direct connection, coupling, or belt drive.

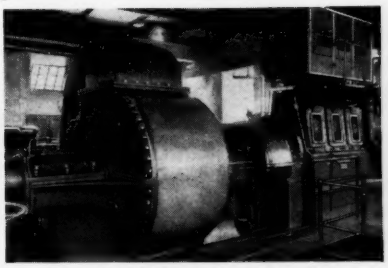
"Universal Unaflow" Engines are correctly designed for simplicity, dependability, heavy duty service, flexibility, low maintenance and permanently maintained economy. They are available in sizes ranging from 75 to 2250 hp., and in horizontal or multi-cylinder vertical types. Without involving you in any expense or obligation, our engineers will give you complete data and figures on an installation to care for your needs.

GENERATING Your Own Electric Power

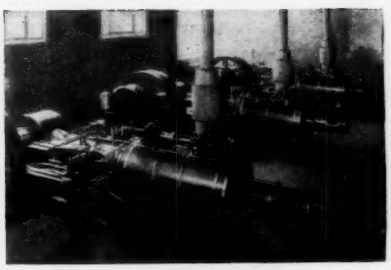
DRIVING Compressors, Blowers, Pumps, Lineshafts, and Other Loads



Horizontal Type, Direct Coupled to Compressor



Vertical Type, Direct Coupled to Blower



Horizontal Type, Direct Connected to Electric Generator

Skinner "Universal Unaflow" engines are frequently bought under our Guaranteed Saving Contract, payments being made out of proved savings after the engine is in service. Write for detailed information of the advantages of Skinner "Universal Unaflow" engines in your industry.

For Over 75 Years, Doing One Thing Well—Building Steam Engines

SKINNER ENGINE COMPANY, ERIE, PA.

"Flexitallic" GASKETS
How Flexitallic Precision Brings a New Degree of Safety
for sealing steam and other fluids under pressure
FLEXITALLIC GASKET CO.
8th & Bailey Sts.
Camden, N. J.

NEW SAFETY IN GASKETS
—will you read about it?

This new little book speaks of safe-sealing for fluids under pressure with the plain honesty the subject of safety deserves.

It tells with sketches and few words how the "Flexitallic" art which established itself in wide use through safe performance has now put safety on a new level.

You are not asked to abandon one theory and accept another. The book deals with a record of performance and identifies the practices that make the record possible. You are urged to believe only what pre-testing can—and will—prove to you.

WE'LL SEND YOU A COPY

A post-card will serve but you will help us in record-keeping by giving us the name of your company and your title or department.

"Flexitallic"

GASKETS OF THIS NAME ARE MANUFACTURED ONLY BY

FLEXITALLIC GASKET COMPANY

ORIGINATORS OF SPIRAL-WOUND GASKET CONSTRUCTION

8th & BAILEY STREETS CAMDEN, N. J.

plants and steam distribution systems; and will also superintend the coordination of engineering and construction activities and construction schedules for the utility.

The new position has been occasioned by the unusually large construction program of 192,000 kw of additional electric generating facilities announced by Ohio Edison Co. during recent months.

MACNEILL TO RECEIVE LAMME MEDAL

THE 1946 LAMME Medal of the American Institute of Electrical Engineers has been awarded to John B. MacNeill, Manager of the Switchgear and Control Division of the Westinghouse Electric Corp.

The medal will be presented to Mr. MacNeill at the Summer General Meeting of the Institute, to be held in Montreal, Que., June 9-13, 1947.

Leo H. Rich, Inc., industrial consultants, has announced the opening of offices at One Wall Street, New York.

Prof. Eugene W. Boehne, coordinator of research and development in the Philadelphia works of the General Electric Co., has been appointed associate professor in the department of electrical engineering at the Massachusetts Institute of Technology, it was announced recently.

National Bureau of Standards has announced the appointment of Donald I. Graham, Jr., as Safety Director of the Bureau and Chief of the Safety Section. Mr. Graham comes to the Bureau from the Safety and Security Division of the Office of the Chief of Ordnance, War Department, where he has been engaged in safety studies with regard to the handling, storage, and destruction of military explosives.

MANUFACTURERS' *News*

PACIFIC ENTERPRISE CHANGES NAME

ENGINEERING Controls, Inc. is the new corporate name of the firm of manufacturing, designing and consulting engineers who, for many years, have operated internationally under the name of Pacific Enterprise Products Co. Lloyd C. Harbert, formerly vice president and general manager, is now President of the new corporation. William G. Corey, consulting engineer of Los Angeles, is Vice President in charge of engineering and Forrest W. Monroe of Forrest Monroe & Associates, Income Tax Consultants, is Secretary and Treasurer.

Included in the reorganization are plans for greatly expanded plant facilities and enlarged engineering personnel. Main offices continue at the present location, 2833 East 11th Street, Los Angeles 23, Calif.

B. & W. RENOVATE FOUNDRY

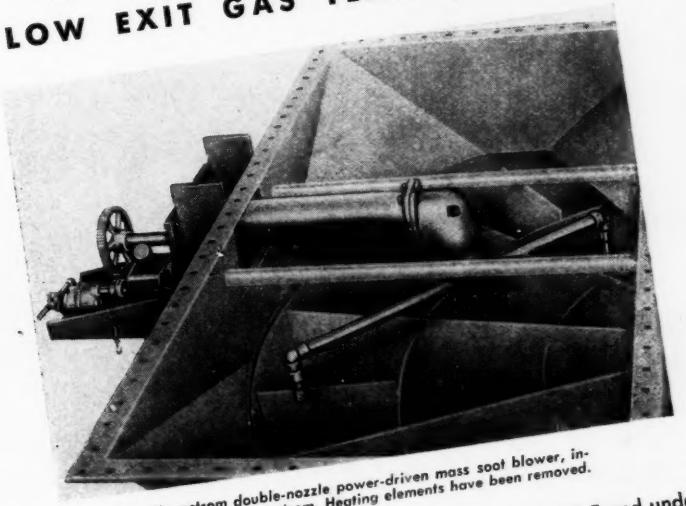
COMPLETE renovation of the Grey Iron Foundry of The Babcock & Wilcox Co. plant in Barberton, Ohio, at a cost of more than half a million dollars was announced recently. The renovation will include improvements to the building as well as machinery replacements and new equipment. Officials predicted that when the program is completed working conditions at the foundry will be comparable to those in any other type shop. In addition, it will make the foundry as modern as any in the industry and increase its capacity.

The program, designed and carried out by the Staff Engineering Department, under the direction of George J. Hartnett, Jr., is part of the recently announced improvement program of the company, though its cost is in addition to the $1,500,000 appropriated for the modernization of the plant. It represents

ENGINEERING PROGRESS REPORT #13

LJUNGSTROM AIR PREHEATER

HIGH SULPHUR FUELS AND LOW EXIT GAS TEMPERATURES

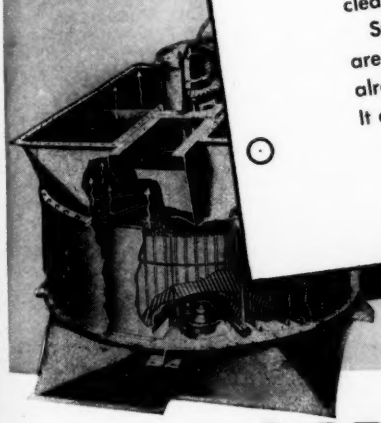


Ljungstrom double-nozzle power-driven mass soot blower, installed in a Ljungstrom. Heating elements have been removed.

If you are operating with a low exit gas temperature, (300 F and under) and are burning high sulphur fuels, (2 to 4 per cent sulphur) deposits are formed on the low temperature end of the heat-exchange surface.

With the Ljungstrom Air Preheater, a special mass soot blower, either single or double nozzle, can apply a high-velocity jet of steam or air at the cold end, with the nozzle only inches away from all the deposits. This removes them and reduces the rate of corrosion. The unit may be cleaned while in full operation.

Standard equipment on all new Ljungstroms, the mass soot blowers are currently available at nominal cost for application to Ljungstroms already in operation. Installation of the mass soot blower is simple. It can be added to most Ljungstroms over the week-end shut down.

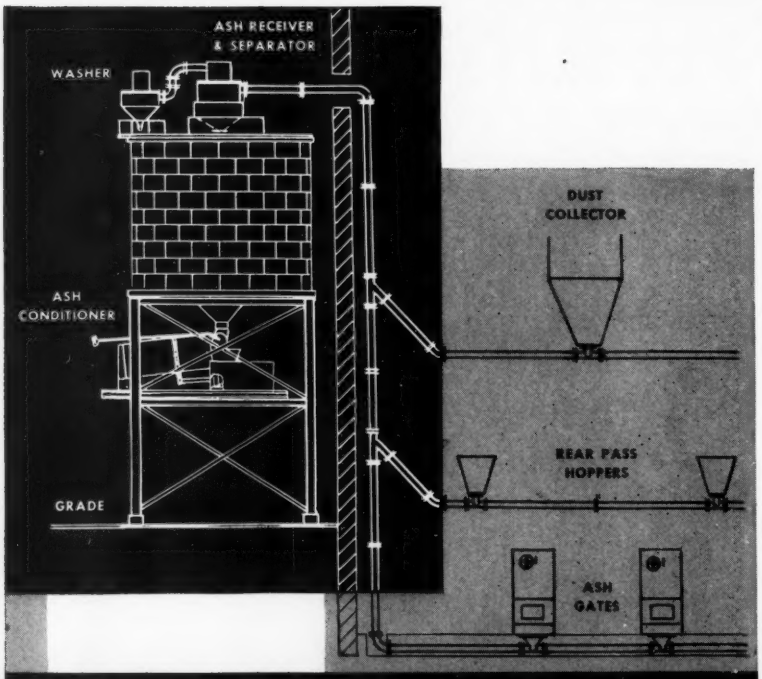


THE

AIR PREHEATER

CORPORATION

Executive Offices: 60 East 42nd Street, New York 17, N. Y. • Plant: Wellsville, N. Y.



CUT ASH REMOVAL COSTS . . .

WITH A BEAUMONT *"Vac-Veyor"* SYSTEM

Want to lower your ash removal costs—and obtain increased efficiency and greater cleanliness at the same time?

The Beaumont "Vac-Veyor" System offers you the most direct and simple method for doing it.

With this system, the ashes, siftings, soot and dust are conveyed from the ash pits, dust collectors, stack, etc. to an ash receiver and separator at the top side of a silo—through a pipe, by means of a vacuum.

Only one man operates the system—keeps your plant cleaner with less labor. Initial and operating costs are rock-bottom. Maintenance costs stay constantly low.

If your needs are immediate—phone us. If you want more information—write. But start cutting those costs NOW.

BEAUMONT BIRCH *Company*

1503 RACE STREET • PHILADELPHIA 2, PA.

Designers Manufacturers Erectors BULK MATERIAL HANDLING SYSTEMS

the largest single amount to be spent on any one shop. The program, already in progress, will be carried out without interrupting production and will be completed this year.

DRESSER JOINS SANTA FE

THE SANTA FE TANK and Tower Co., with its main office in Los Angeles, has announced the addition of Harold A. Dresser to its Engineering Staff. Mr. Dresser, formerly of the Fluor Corp., has taken over the Cooling Equipment Division of Santa Fe as part of a sustained program to enlarge its present facilities to cope with an ever-increasing clientele. This latest move represents a significant milestone in the history of Santa Fe, inasmuch as Mr. Dresser is nationally recognized as one of the foremost authorities in the cooling equipment industry. Mr. Dresser, an alumnus of the California Institute of Technology, has been associated with the cooling equipment industry since 1926.

JENKINS BROS. ELECTS NEW OFFICERS

ALFRED J. YARDLEY has been elected president of Jenkins Bros., succeeding his father, Farnham Yardley, who becomes chairman of the board, after serving as president for the past 30 years.

Alfred Yardley joined the firm in 1932 at the plant in Bridgeport, Conn. A great grandson of Nathaniel Jenkins, the founder, he is the fourth president of Jenkins Bros. in the 83 years of the company's existence.

The company also has announced the election of James L. Dunn, vice president in charge of industrial relations, and C. C. Chamberlain, general sales manager, to the board of directors.

Mr. Dunn joined Jenkins Bros. in 1913 as a valve assembler in the Bridgeport, Conn. plant. In succession he advanced to timekeeper, payroll clerk and cost clerk. After two years in service during World War I, he returned to Jenkins Bros. as rough stock clerk. He rose to production manager, business manager and assistant plant manager, and in 1944 was named vice president in charge of industrial relations.

Mr. Chamberlain joined the company in 1929 on graduation from Hamilton College. Starting as an assistant in the advertising department, he was appointed advertising manager in 1932, and advanced to publicity manager in 1940. He was named general sales manager in 1942.

HAYS CORPORATION APPOINTMENTS

PHIL T. SPRAGUE, President of The Hays Corp., Michigan City, Ind. has announced the following appointments:

Shirl M. Rudolph to be Vice President in Charge of Sales. Mr. Rudolph has served the Hays Corp. since 1920 in the Accounting Department, as Factory Manager, as Assistant to the President and in various sales capacities.

William H. Pugsley is to be Vice President in Charge of Field Research. Mr. Pugsley joined the Hays Corp. in 1932 as Manager of the Combustion Control Division after sales and office experience in Cleveland and Chicago offices. He has travelled widely in studying new applications and in developing new markets as well as to lecture before Engineering organizations. Working closely with Engineering and Sales Departments, he has supervised the organization of educational courses for salesmen and service engineers and in arranging demonstration equipment and sales visuals.

IDDLES NEW DIRECTOR OF BABCOCK & WILCOX

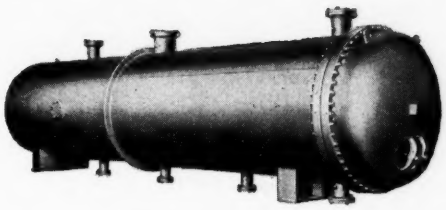
ALFRED IDDLES, who has been associated with The Babcock & Wilcox Co. since 1937 and a Vice President since 1945, has been elected as a Director of the Company. Directors re-elected include: Mr. Pratt, E. G. Bailey, John Foster Dulles, C. W. Middleton, Robert C. Stanley, B. A. Tompkins and John C. Traphagen.

Mr. Iddles has had many years' experience in engineering work, especially the design and

HOW G-R has led in EVAPORATOR DESIGN and APPLICATION

1st. ..... G-R DEVELOPED

- THE FIRST *marine evaporator*
- THE FIRST *stationary evaporator*
- THE FIRST *"multiple-effect" system*
- THE FIRST *"associated" system*
- THE FIRST *"scale-shedding" elements*
- THE FIRST *"reducing valve" system*
- THE FIRST *"waste heat" evaporator*

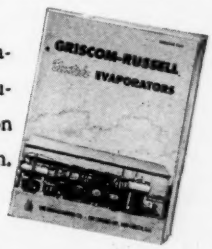


The many G-R "firsts" in the development of evaporators for producing pure boiler feed make-up indicate the leadership which has resulted in installations serving a total of more than 40,000,000 boiler horsepower.

The different types of evaporator systems which have been originated by G-R provide an efficient arrangement for a wide variety of requirements . . . for example; "associated" systems for maximum heat economy in high-duty plants, "reducing-valve" systems for economical generation of process steam in industrial plants, "waste heat" evaporators for recovering the heat from hot process fluids in petroleum refineries and chemical plants.

In addition, the many distinctive features of G-R Bentube Evaporators . . . their scale-shedding elements, provisions for pure dry vapor, dependable operation, and convenience of access to all parts . . . assure economy of attendance and maintenance as well as thorough elimination of all raw-water impurities.

Investigate G-R Bentube Evaporators . . . write for Bulletin 364 and authoritative advice, without obligation, on your boiler feed purification problem.



THE GRISCOM-RUSSELL CO.

285 Madison Avenue • New York 17, N. Y.

GR-185

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

Standard for Safety!

Above—No. 101

Left—No. 102

DAVIS BOILER
STOP and CHECK
VALVES

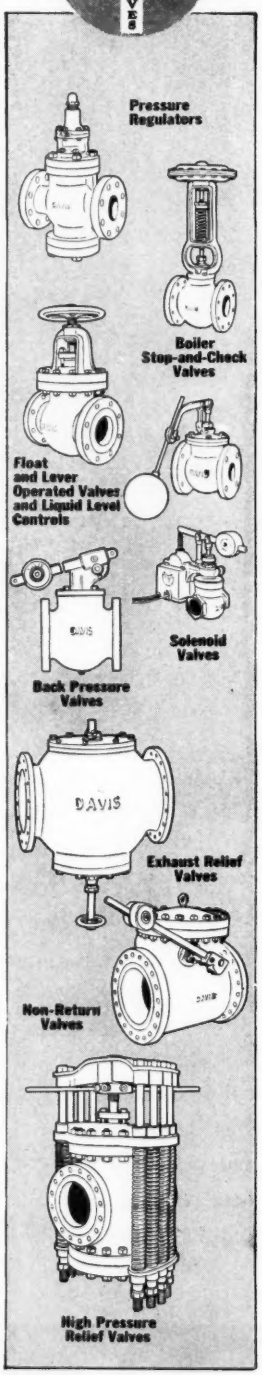
● Davis Stop-and-Check Valves have long been "Standard for Safety" in boiler plants throughout the nation.

NO. 101—Designed particularly for finest high pressure, heavy duty steam plants. Features an external oil dash pot and counter-weighted lever which can be moved by hand at any time to test the valve and also provides visible action. Inside, it is as clean and simple as a streamlined globe valve.

NO. 102—The popular valve for general service. Features an ingenious valve design with internal steam dash pot eliminating any tendency to chatter.

BOTH TYPES are available in a complete range of sizes. Globe, angle, corner or elbow body patterns. Semi-steel, carbon steel, or alloy steel bodies, with suitable trim for any pressure and temperature. For prompt service, send an outline of your requirements.

DAVIS VALVES



DAVIS REGULATOR CO.

Representatives in All Principal Cities

2508 S. WASHTENAW AVE., CHICAGO 8, ILL.

construction of power generating plants. For the past ten years he has been intimately associated with the engineering activities of The Babcock & Wilcox Company.

BAILEY METER ELECTS VICE PRESIDENTS

BAILEY METER CO. announces the election of H. M. Hammond, former general sales manager, and P. S. Dickey, former chief engineer, as vice presidents.

Mr. Hammond was graduated from Rensselaer Polytechnic Institute in 1918 and served as a naval officer before joining Bailey Meter Co. as a field engineer in 1919. He was assigned to the Ohio-Pennsylvania area and became Philadelphia branch manager in 1921. In 1923 he was appointed sales manager.

Mr. Dickey is a graduate of Purdue University and has been associated with Bailey Meter Co. continuously since 1925. In 1934 he became chief research engineer and in 1940 special consultant on marine problems. He was appointed chief engineer in November, 1944.

The Cleveland Worm and Gear Co. and The Farval Corp., Cleveland, Ohio, have announced the appointment of George F. Heath as District Sales Representative with offices at 4030 Chouteau Ave., St. Louis 10, Missouri.

Ladish Co., Cudahy, Wisconsin has announced the establishment of a new district office in Atlanta, Georgia and the discontinuation of its New Orleans office. The new office will be located at 452 Spring Street, N.W. and will serve the southeastern territory. W. W. Bowie, formerly manager of the New Orleans office, has been appointed manager of the Atlanta office to direct the sale of the company's complete line of seamless welding fittings, forged steel fittings and Ladish forged steel flanges in this territory.

The Dampney Co. of America has announced the appointment of Combustion Equipment & Insulation Co., 1900 Euclid Avenue, Cleveland, Ohio, as agent in the Cleveland area for the sale of Apexior and Thur-Ma-Lox protective coatings.

Ken. O. Hood is the new Pacific Coast District Manager for the Falk Corp., Milwaukee, it was announced recently. With headquarters in Los Angeles, he will direct Falk sales in California, Washington, Oregon, Nevada, New Mexico, Arizona, Colorado, Utah, Idaho and parts of Wyoming.

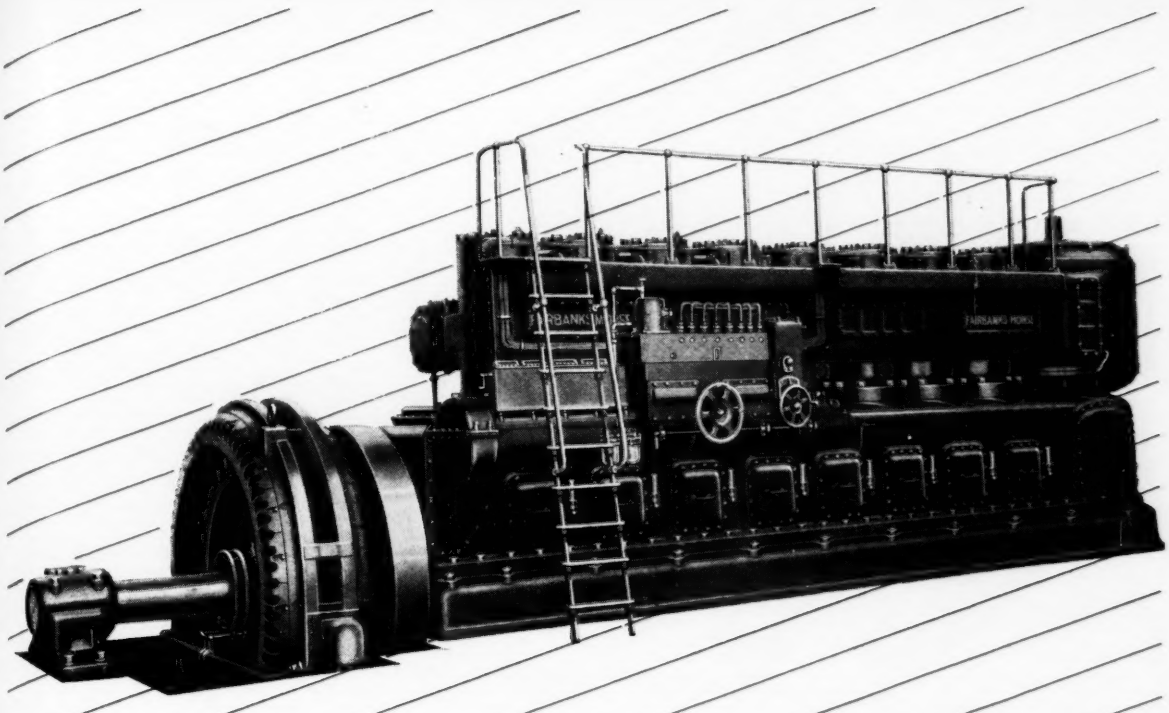
J. A. Bynum, who has been district sales manager for Reading-Pratt & Cady Division of American Chain & Cable Co., Inc., in the southwest for many years, has been appointed special representative on Reading-Pratt & Cady valves for the petroleum industry in that area. J. J. Reed has been appointed district sales manager to succeed Mr. Bynum. For most of the past 5 years Mr. Reed has been located at the factory in Reading, Pa.

The H. K. Ferguson Co. recently announced the appointment of Dr. Gwoh-Liang Lee as its representative in China with headquarters at Hankow.

Dr. Glenn T. Seaborg, professor of chemistry at the University of California and co-discoverer of the artificial element plutonium used in one form of atomic bomb, has been named as consultant in nucleonics to the General Electric Research Laboratory in Schenectady.

A. D. Robertson, formerly assistant manager of sales and engineering of the electrical section at the Norwood, Ohio, Works of the Allis-Chalmers Mfg. Co., has been named manager of the company's Tampa, Fla., district office succeeding the late Berrien Moore.

I. C. Matheson, formerly of the Allis-Chalmers Tampa District office, has been transferred to the company's Los Angeles office, where he will specialize in the handling of utility business for the company in that area.



FAIRBANKS-MORSE DIESELS

PROVED by Performance

No more conclusive evidence of Fairbanks-Morse Diesel superiority exists than the actual records of their performance. In every instance, the story is the same: Fairbanks-Morse Diesels are sparing on fuel costs . . . ask minimum maintenance . . . have maximum reserve power . . . operate efficiently through sustained, heavy-duty service.

If more power—and lower power cost—are what you need, have a Fairbanks-Morse power engineer study your problem. No cost, no obligation—write now for particulars. Fairbanks, Morse & Co., Chicago 5, Illinois.

Fairbanks-Morse

A name worth remembering

Diesel Locomotives
Diesel Engines
Generators • Motors
Pumps • Scales
Magnetos • Stokers
Railroad Motor Cars
and Standpipes
Farm Equipment

DART

The Union for Leak-Proof Protection

THE TWO BRONZE SEATS ARE GROUND TO FORM A TRUE BALL JOINT

Dart Unions insure leak-proof protection because their two bronze seats are precision-ground. This means that they fit tighter and close easily, without excessive wrenching, to a drop-tight connection. Despite length of service, they uncouple easily for use elsewhere—and they cost least in the long run. Body and nut, made of high-test, air-refined malleable iron, are practically indestructible.

Ask your supplier to demonstrate the many features of Dart Unions.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE 5, R. I.

Arthur D. Brown, formerly manager of the Los Angeles Allis-Chalmers district office, has been named manager of the company's Washington, D.C. office, according to an announcement by J. L. Singleton, manager of district offices. R. N. Landreth, who has been acting manager of the Washington, D.C. office, will now devote full time to his special duties as assistant to W. C. Johnson, vice-president of Allis-Chalmers' general machinery division.

Announcement is made by the Goodall Rubber Co., Inc., the opening of an affiliated company to be known as the Goodall Rubber Co. of Minnesota. This new company, formerly the Minnesota Rubber & Supply Co., is located at 2482 University Ave., St. Paul, Minn. Leonard Berg has been made vice president and branch manager. A fully stocked warehouse carrying the company's complete line of industrial hose, beltings, packings, boots, gloves, aprons and clothing will be maintained there.

Frank E. Lobaugh, formerly Technical Service Manager, has been appointed Technical Service Director of the Lumnite Division, Universal Atlas Cement Co., United States Steel Corp. Subsidiary. In 1941 Mr. Lobaugh joined The Atlas Lumnite Cement Co., now the Lumnite Division of Universal Atlas, in the Technical Division and Sales Department. In 1944 he was appointed Technical Service Manager which position he has held until his appointment as Technical Service Director.

The Hammel-Dahl Co., Providence, R.I., announces the appointment of Nielsen & Fryer, Inc., 152 East Superior Street, Chicago 11, Ill., as its Dealer Representative. This company will assume complete responsibility for sales in the Chicago Trading Area, including Terre Haute, Ind., east to Ft. Wayne, west to the Iowa State line and north to the Canadian border, along the west shore of Lake Michigan.

Liquid Conditioning Corp., Linden, N.J. announces the appointment of William O. Lovejoy as its representative in Florida. Mr. Lovejoy will handle the sale of the Company's Liquon equipment and Liquonex materials for all water treatment processes and for conditioning of other liquids, having had long and extensive experience in these fields. For a number of years, Mr. Lovejoy was in charge of the filtration plant of the Louisville, Kentucky Water Works. Mr. Lovejoy's headquarters are at 1366 Holmesdale Road, Jacksonville 5, Florida, telephone Jacksonville 9-7058.

MANUFACTURERS' *Personals*

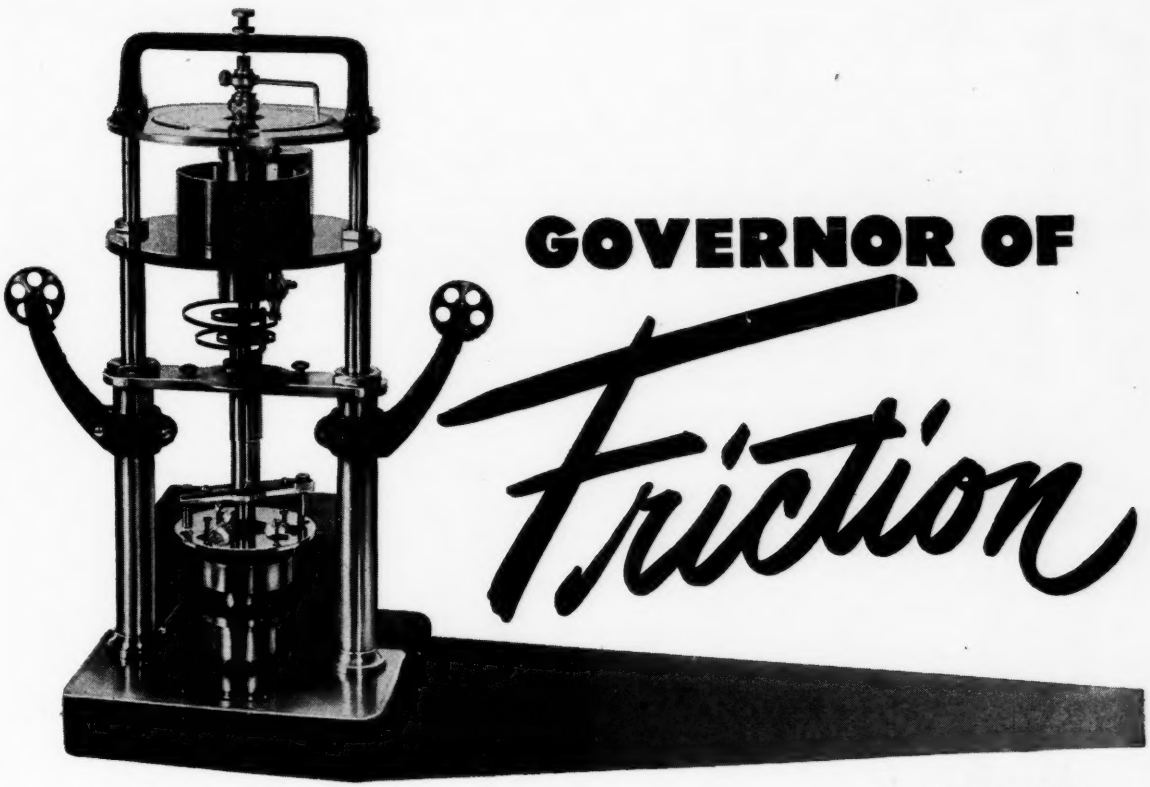
GARDNER-DENVER'S NEW OFFICERS

EDGAR F. SCHAEFER, executive vice-president of Gardner-Denver Co., was elected company president and H. G. Myers, former president, became chairman of the executive board at the annual stockholders meeting held recently.

In assuming chairmanship of the executive committee, Mr. Myers takes the post formerly held by the late J. W. Gardner, and in this capacity will be actively associated with the affairs of the company. Mr. Myers joined the Gardner-Denver Co. in 1927 as chief engineer. In 1929 he was made executive vice-president and in March of 1935 was elected president, succeeding W. H. Leonard, who became chairman of the board of directors, the post he still holds.

Mr. Schaefer came to the Gardner-Denver Co. in July of 1919. He was elected vice-president in 1926, and became executive vice-president in 1942.

R. R. Donaldson, acting chief engineer of Hagan Corp. for several months since the retirement of T. A. Peebles, has been appointed chief engineer, D. J. Erikson, vice president, announced recently. Mr. Donaldson started with Hagan in the field of combustion



GOVERNOR OF *Friction*

(*Herschel Coefficient of Friction*)

As power is the life blood of industry, friction is the deadly poison that can slow wheels, reduce efficiency to the point of disaster.

Correct lubrication, obviously, is the preventive which protects power against the depredations of friction. And . . . the coefficient of friction of a lubricating oil is an important factor in the utilization of input power in all machines.

Sinclair Research is ever alert to aid you in developing maximum output from your equipment with such apparatus as the Herschel Coefficient of Friction machine, shown above. This machine is invaluable where lubrication of all parts of machinery is concerned.

With such apparatus and the continuous effort of skilled experts in refinery control, Sinclair assures you of outstanding performance from lubricants developed specially for your specific application.

Sinclair Power Plant Lubricants
FOR MINIMUM FRICTION—MAXIMUM POWER

For Turbines:
SINTURLITE OILS

For Steam Cylinders:
SINCLAIR STEAM CYLINDER AND VALVE OILS

For Compressors:
RUBILENE OILS

For Ball and Roller Bearings:
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SINCLAIR

Lubricants for Industry

FINEST CRUDES + EXPERT RESEARCH and MANUFACTURING CONTROL = OUTSTANDING PERFORMANCE

TOPS

FOR BOILER ROOM *Safety*

Hundreds of engineers regard SONDERGLASS as "tops" for safety and economy in boiler room operation . . . In repeated tests it has been dipped in hot oil at 450 deg. F., then plunged in cold water without breaking; tested up to 1000 lb. steam pressure without failure. For the utmost in safety order SONDERGLASS . . . from your dealer or directly from us.

CLEAR

Comes in two popular types: CLEAR for use where water column is well lighted; REFLECTING with red and white enamel background to make water level visible as a bull's-eye.

REFLECTING

SONDERGLASS

"The Universal Gauge Glass"

A. W. CHESTERTON CO.

6 ASHLAND ST., EVERETT STATION, BOSTON 49, MASS.

DISTRIBUTORS IN PRINCIPAL CITIES

"Boiler Repairs Reduced 75%"

writes user of **NATIONAL GIRTH SEAM PROTECTOR**

We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.

Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 928-29 REIBOLD BLDG., DAYTON, OHIO

control of steam boilers immediately after he returned from the army in 1918 and has been an important member of its engineering staff ever since. He assisted in the development of new control mechanisms and their application to steel and other industries and was in large part responsible for adaptation of automatic combustion control to the marine field in 1935 and 1936.

John F. Marquitz has been appointed Assistant Manager of the Railroad Division of Fairbanks, Morse & Co., Chicago, Ill., according to a recent announcement. Mr. Marquitz succeeds John S. King, who only a short time ago, was appointed Manager of the company's Chicago Branch. He brings to his new job a very diversified background of sales experience covering nearly 40 years of service with the company.

The Chicago offices of Tube Turns, Inc., Louisville, Ky., have moved to suite 904 Fairbanks-Morse Building, 600 South Michigan Avenue. The phone number, Harrison 8527, remains the same. The new and larger offices will be the headquarters for George C. Anderson, District Manager of Tube Turns' Welding Fittings Division, Donald A. MacNeil, District Manager of Tube Turns' Forging Divisions, and their staffs.

Perfex Corp., Milwaukee, has announced that V. Robins Tate, Vice President and Secretary of the firm, was elected Executive Vice President at the February meeting of the Board of Directors. It was also announced that Hugh Kelly has been named Chief Engineer. The company also has announced the appointment of Chris J. Jensen, Sr., as foreign representative and engineer. He will make his headquarters in Oslo, Norway, working with European manufacturing accounts and the Perfex exporting agent, in educational programs.

Elgin Softener Corp., Elgin, Ill., has announced that Fred S. Crook has been appointed District Engineer of their St. Louis territory, which includes eastern Missouri, southern Illinois and western Kentucky. Mr. Crook will retain the present St. Louis headquarters in the Paul Brown Building.

R. Tom Sawyer, American Locomotive Co. engineer who is widely known as an author and speaker on practical and theoretical design and application of all types of motive power, has been appointed manager of the company's Research Department it was announced recently. His offices will continue to be in New York City.

Paul J. Maddox, Assistant Vice President of the Laclede-Christy Clay Products Co., St. Louis, Mo., has been appointed General Sales Manager of the Refractories Division of the company. This is the largest Division of the company and is responsible for the sales of Suspended Arch and Supported Walls, High Temperature Cements and Mortars, all grades of Fire Brick through the company's direct salesmen, branch offices, dealers and agents.

A. H. Jones, well known for many years on the West Coast as manager of the Gardner-Denver Co. branch office in Los Angeles, has been appointed director of the Export Office in New York City, according to an announcement made recently. Mr. Jones was also elected vice president of the newly formed Gardner-Denver Western Hemisphere Co. with offices in New York.

Rudolph E. Reimer, Secretary and Treasurer of Dresser Industries, Inc., Cleveland, Ohio, also was elected a Vice President of the company at a meeting of the Board of Directors in New York recently.

D. J. Erikson, vice president and general sales manager of Hagan Corp., Hall Laboratories and Calgon, Inc., will revisit the Pacific Coast this summer for six weeks. He will stop at Los Angeles, San Francisco, Portland and Seattle, checking with each branch representative on progress in combustion control and boiler water conditioning. He also will initiate a reorganization of plans to take into account the company's recent purchase of the Ring-Balance Instrument Co. of Chicago, which rounds out the Hagan line of controls with a wide line of instruments.

AT STRATEGIC LOCATIONS FOR YOUR CONVENIENCE

ENTERPRISE

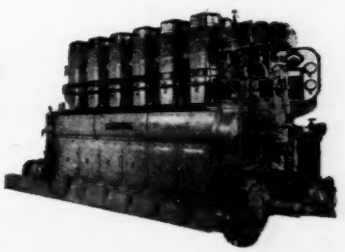
NATION-WIDE SERVICE

Parts and service for Enterprise Diesel Engines are supplied by one of the most complete organizations in the Diesel Industry. Enterprise Representatives are located not only at these key points throughout the nation but are also international in scope, offering uniform Enterprise service throughout the world. In addition, a thoroughly trained staff of experienced engineers is at all times available for consultation. This immediate, expert service means lower maintenance cost and greater dependability. When you select Enterprise, these services become yours, as a vital part of your diesel application. We invite you to investigate the advantages of Enterprise Diesel Engines and Enterprise Service.

STATIONARY AND MARINE

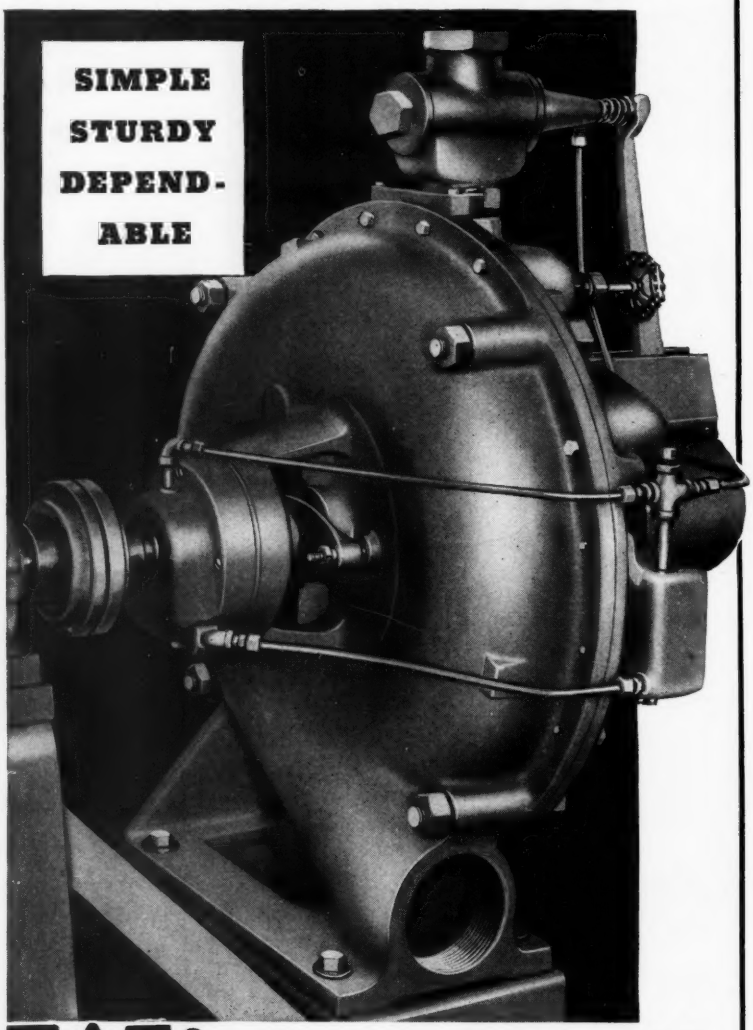
DIESEL ENGINES

ENTERPRISE ENGINE & FOUNDRY CO.
18TH AND FLORIDA STREETS
SAN FRANCISCO 10, CALIFORNIA



DIESEL ENGINES • PROCESS MACHINERY • OIL BURNERS • HEAVY MACHINERY

XUM



Wing AUXILIARY STEAM TURBINES

FOR DRIVING FANS, BLOWERS, PUMPS, COMPRESSORS, GENERATORS, STOKERS, WINCHES, etc.

FEATURES:
CAPACITIES—up to 150 h.p.
SPEEDS—up to 4,000 r.p.m.
Capable of Exhausting against HIGH BACK PRESSURES
SHAFTS—Horizontal or vertical
ROTATION—Clockwise or counter-clockwise

LUBRICATION—Wing Filtered Oil Lubricating System or Grease
GOVERNOR—Overspeed trip and Speed Regulating
OIL-FREE EXHAUST STEAM may be used for heating or process work.

Write for Bulletin

L. J. Wing Mfg. Co. 64 Seventh Avenue, New York 11, N. Y.
Factories: Newark, N. J. and Montreal, Canada

TURBINE BLOWERS • TURBINES • • FANS • MOTOR DRIVEN BLOWERS
REVOLVING UNIT HEATERS • UTILITY HEATERS • FIXED DISCHARGE UNIT HEATERS
DUCT FANS • DRAFT INDUCERS • HEATER SECTIONS • SHIP VENTILATORS • FOG ELIMINATORS

HELPFUL BULLETINS

(*Continued from page 52*)

packing. An exceptionally useful section of the booklet is a recommendation chart showing the style numbers of packings recommended for practically every type of service. Asbestos Packing & Textile Div., Raybestos-Manhattan, Inc.

TREATING, CONDITIONING

32 **Clean Oil**—Vol. 3, No. 1 of "Clean Oil" a quarterly publication is now ready for distribution. One of the articles in the booklet shows how one company saved $6000 a month by using this company's oil purification equipment. Two other interesting case histories are also given in the magazine. One of these shows the effectiveness of oil purification on Diesel lubricating oil and the second tells how a California plant eliminated dermatitis by purifying cutting oil. The booklet is profusely illustrated and is printed in two colors. Honan-Crane Corp.

33 **Chemical Feeding for Water Treatment**—Bulletin 101-B, "Corrective Chemical Feeding," is a 12-page folder which describes the company's equipment for proportioning chemical feeding to raw water. The method followed in this proportioning is described in detail and methods of determining and controlling dosages are given. Illustrations show not only the equipment but typical assemblies of various pieces of equipment with connections. A guide to the selection of the company's chemical feeders and lists of typical specifications is given. The American Water Softener Co.

34 **Synthetic Ion Exchange**—This 18-page booklet covers the subject of synthetic ion exchange resins and the action of these resins in water treatment. Flow diagrams and cycles of operation in exchange processes and the reduction of alkalinity are presented effectively and chemical aspects of the exchange process are explored. A listing of the advantages of synthetic resin exchangers is given. Illustrations show commercial and industrial deionizing equipment as installed. Applications of the "Amberlites" to water softening, reduction of alkalinity, reduction of total solids comprise one of the most useful sections of the booklet. Methods of use of the Amberlites is another section of the literature. Literature references are given at the end of the bulletin. The Resinous Products and Chemical Co.

35 **Sludge Solvents**—Facts about sludge solvents are given in this 4-page bulletin. The booklet first outlines the causes of sludge formation and then briefly describes the principle of sludge control. It calls attention to diluents sometimes used (such as kerosene or light fuel oil or caustic soda) and then tells what the effective ingredients of a well-balanced sludge solvent should be. Specifications for such a solvent such as wetting agent, alcohol, chlorinated solvent, etc. are given. A complete description of the company's treatment for sludge formation in fuel and Diesel oils is described on the last page of the folder; a table of prices is included. O'Brien Industries.

36 **Antifoaming Compound**—This new pamphlet from the company's "Silicone Notebook" describes the physical properties of DC Anti-Foam A which was recently developed for killing foam in aqueous systems. The company points out that the compound has proved its usefulness in a wide variety of industrial processes including steam distillation and vacuum evaporation. Physical properties of the compound are described and directions on how to use it are given. Tables and charts are presented. Specific directions for its use in various industries are given on the last page of the folder. Dow Corning Corp.

AIR COMPRESSOR LUBRICATION

Solving AIR COMPRESSOR TROUBLES

Lubrication Engineer's Report:

"A mining company* in the Joplin area was having trouble with the unloading valve on an Angle Compound Air Compressor. They were also troubled with discharge valve breakage of the high pressure cylinder.

"The previous oil was replaced with Cities Service North Star Oil No. 5 and not a single instance of gumming or sticking or trouble of any kind with the unloading valve or discharge valve has been reported in over two years."

Case No. 1:

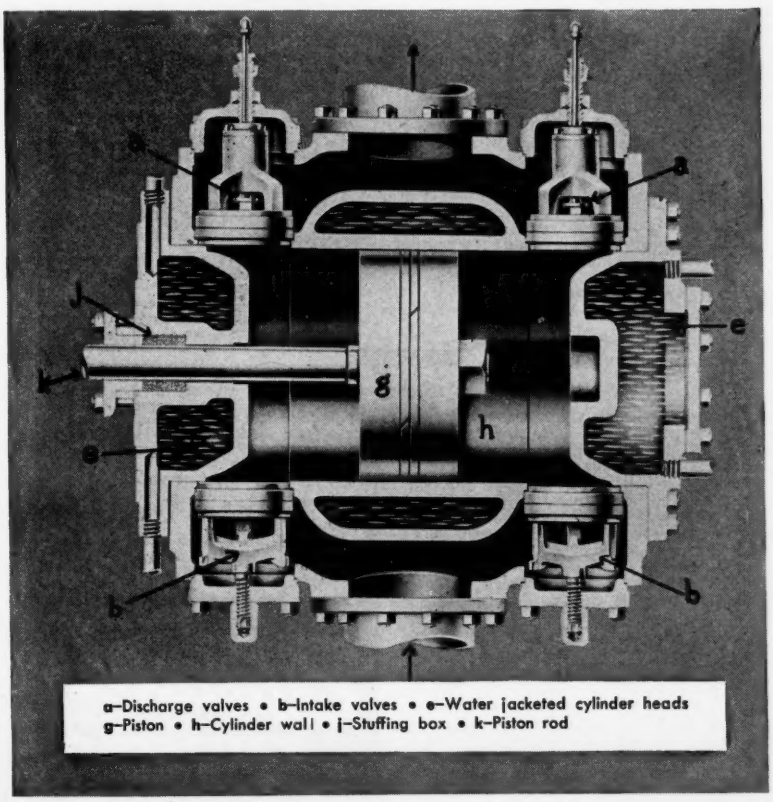
"A utility plant* in Springfield, Mo., uses compressed air from a single stage belt-driven air compressor in connection with overhauling jobs of the boilers in their plant. They are all of the water tube type and are overhauled at regular intervals. During these overhauls they need a constant supply of air. The unloading valve of this compressor would gum up to the extent that they would have to clean it about every other day when using a competitor's oil. I sent them a drum of Cities Service North Star Oil No. 5 about a year ago, and checked with their Chief Engineer last month. He tells me they haven't had to clean the unloading valve since putting in the North Star Oil."

Case No. 2:

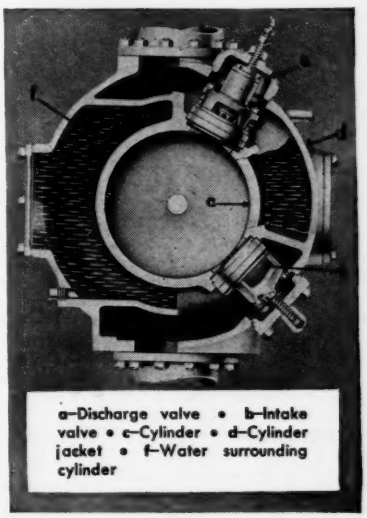
"We have lubricated a 1000 cubic foot two-stage air compressor in the Mid-Continent area for over three years. The customer* says that in using Cities Service North Star Oil No. 5 in this compressor he hasn't had any valve breakage and that carbon deposit on valves and seats has been down to practically nothing."

Case No. 3:

*Names on request.



a–Discharge valves • b–Intake valves • e–Water jacketed cylinder heads g–Piston • h–Cylinder wall • j–Stuffing box • k–Piston rod



a–Discharge valve • b–Intake valve • c–Cylinder • d–Cylinder jacket • f–Water surrounding cylinder

Solving compressor operating problems has been Cities Service's special forte for years. A phone call or card to the Cities Service office nearest you will bring this engineering experience to *your* plant. There is no obligation. For useful information that every air compressor owner and operator should know, write for our free booklet, "Air Compressor Lubrication." Cities Service Oil Co., Sixty Wall Tower, New York 5, N. Y., Room 119

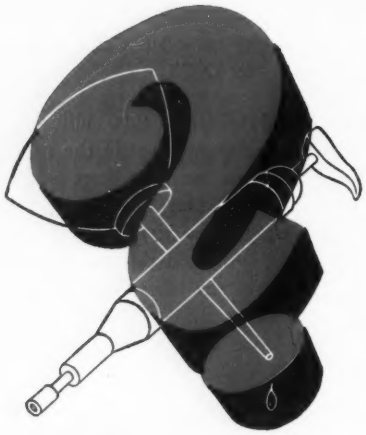
Free Booklet:

Cities Service means Great Service

CITIES SERVICE

Cities Service Oil Co.
NEW YORK - CHICAGO

Arkansas Fuel Oil Co.
SHREVEPORT, LA.



GREASE OR OIL

The question of selection of the proper type and consistency of lubricants need offer no problem. LUBRIPLATE Lubricants are available from the lightest fluids to the heaviest grease types. All reduce friction and wear, protect against rust and corrosion, and are more economical than conventional lubricants. Let us prove our case.

℞ FOR YOUR MACHINERY

No. 2 — Ideal for general oil type lubrication, ring oiled bearings, wick feeds, sight feeds and bottle oilers.

No. 8 — Because of high film strength and long life it reflects outstanding performance in most types of enclosed gears (speed reducers).

No. 107 — One of the most popular grease type products for general application by pressure gun or cups.

No. 70 — For a wide range of grease applications, especially at temperatures above 200 degrees F.

No. 130-AA — Known nationwide as the superior lubricant for open gears, heavy duty bearings, wire rope, etc.

BALL BEARING — This is the LUBRIPLATE Lubricant that has achieved wide acclaim for use in the general run of ball and roller bearings operating at speeds to 5000 RPM and temperatures up to 300 degrees F.

LUBRIPLATE

FISKE BROTHERS REFINING CO.

NEWARK 5, N. J. TOLEDO 5, OHIO

DEALERS FROM COAST TO COAST

CONSULT YOUR CLASSIFIED TELEPHONE BOOK

37 Boiler Feedwater Handbook—"Equipment and Methods for Applying Treatment to Boiler Feedwater," is the title of this recently-issued book. The book first describes the problems to be met and the various methods available for doing the job. The various sections then develop the remainder of the solution logically. Pre-Treatment, Feedwater Treatment, Internal Treatment all are covered and each section is supplemented by line drawings of treatment layouts, and tables. Proportioneers, Inc.

38 Water Conditioning—This recently issued condensed catalog gives complete data on processes and equipment for the conditioning of water and other liquids. A large amount of tabular material in the booklet enables the manufacturer to present a huge amount of detailed information in the smallest possible space. Table 1 lists the impurities in the water, their effects and limits of tolerance for various applications; Table 2 shows the methods of removing impurities and indicates the degree of removal produced. Graphic representations of the results obtained by treating a given water are shown. Methods and equipment for the removal of dissolved gaseous impurities, suspended solid impurities and dissolved impurities, hardness, alkalinity, etc., are presented in handbook form and each section is accompanied by blueprint illustrations. Equipment for special purposes is described. Liquid Conditioning Corp.

39 Corrosion Inhibitor—Technical Data Sheet F-5027-B presents technical information on Morlex corrosion inhibitors for steam boilers and steam heating systems. Specifications and properties of the material are presented in tabular form and the action of the inhibitor in water solutions is described. Concentrations of the corrosion inhibitor necessary to obtain stated pH values in the boiler water and the steam generator are given in a table. Carbide and Carbon Chemicals Corp.

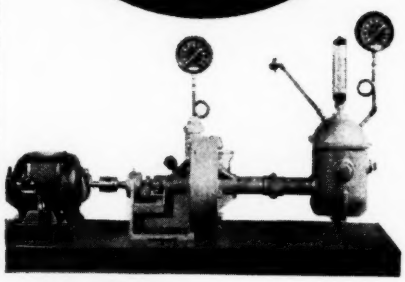
MAINTENANCE

40 Flooring Composition Bulletin — Here is a 4-page bulletin which describes the advantages obtained from the installation of the company's flooring composition. As the bulletin points out, this material must be installed by a contractor trained in the business and the bulletin merely points out the features of the material; some of these features are resilience and flexibility, lack of shrinkage, resistance to oils, fats and greases, fire proof, sanitary and vermin proof, etc. The bulletin further points out that the composition can be applied in one or two coats over wood and that it sets rapidly. It is available in several colors. Photographs of installations and listings of places where the material has been used are given. Selby, Battersby & Co.

41 Maintenance, Safety Equipment — There are 60 pages in this catalog No. 26 describing production equipment, commutator maintenance, motor maintenance, electrical maintenance, safety equipment and mechanical maintenance equipment. The booklet is exceptionally well illustrated with photographs of the equipment and tabular material covers specifications and prices. Brief descriptions of the items are included. The Martindale Electric Co.

42 Tank Linings—An emulsion for coating the interior of cold and hot water tanks is described in this 4-page folder. Features of the emulsion such as: bonds to damp or dry surfaces; stops rust, corrosion and electrolysis; remains rubbery and pliable; will not rub off after drying, etc. are listed. Photographs show the interiors of tanks on which the emulsion has been applied. A detailed description of porcelain line coating also made

Here's how you save by handling Condensate the *direct* Returnal WAY



SAVES FUEL

Because the RETURNAL System returns each pound of condensate to the boiler as fast as formed—also at high pressure and temperature and without flash steam loss from vented receiver—it cuts down boiler load and saves fuel, water and water treatment materials. Fuel savings alone usually exceed 25%.

SAVES MAINTENANCE

Many RETURNAL Systems have been running 6 years without expense other than electricity, lubrication and packing. Often, however, the largest saving is the cost of maintaining traps, which are no longer necessary. Moreover, when flooding occurs in any steam trap system much time and productivity can be lost before it is determined which trap is causing the trouble.

BOOSTS PRODUCTION

Because the RETURNAL System assures hotter steam heated units, no waiting for traps to fill up and dump - - dry, hot steam is made available everywhere all the time. Remember that it takes only a small increase in production to be worth more, in dollars and cents, than a comparatively large saving in fuel.

Now, while fuel is expensive and increased production is worth big money is a good time to check on your condensate return methods—see where and how the improved RETURNAL System can pay back its cost in a few months, then continue to pay dividends for years to come.

Heat Reclaimer Corporation

Engineers and Manufacturers

549 W. Randolph St., Chicago 6, Ill.

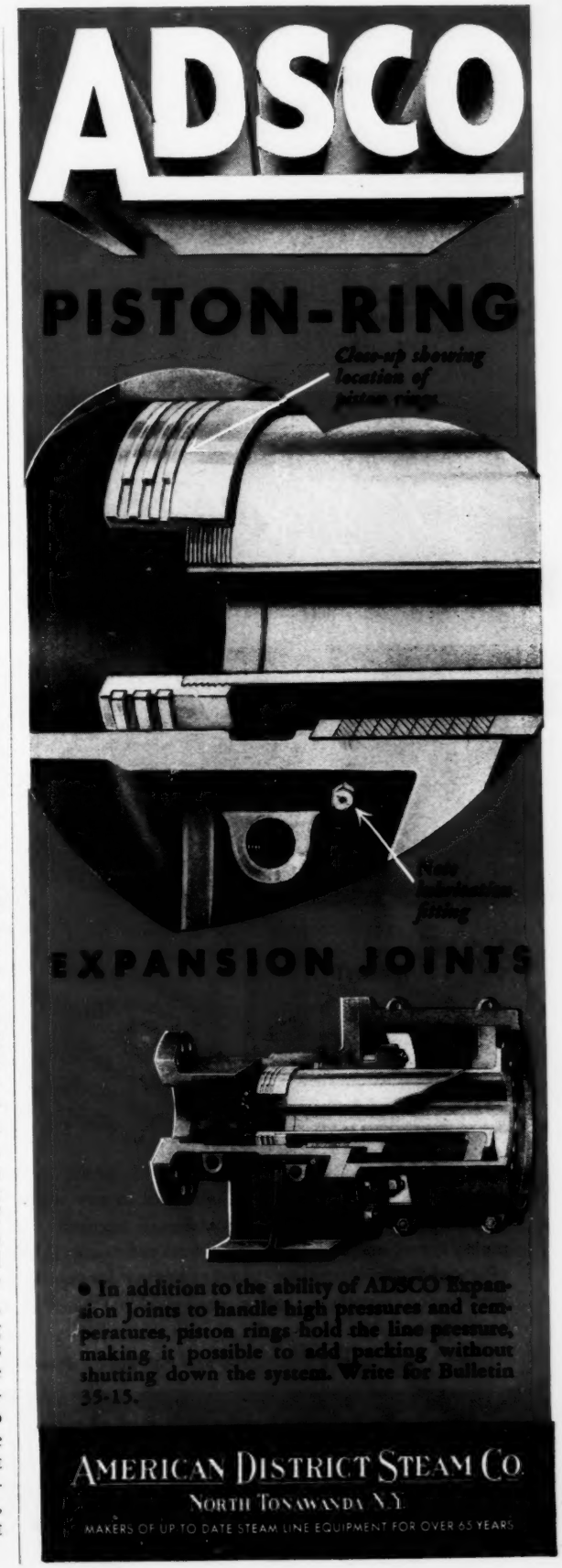
Returnal DIRECT BOILER RETURN SYSTEM

ENGINEERS' PREVIEW

IN THE search for better products, better manufacturing processes and a strong position in national and international markets, American business is spending more money for industrial research than in the years immediately preceding the war, according to the National Industrial Conference Board. Increased emphasis is being placed on such activities as product improvement and application, operations' research and testing, research into processes, production methods and planning, equipment, and control. Generally, also, an increased amount of money is being put into pure research. Improvement and redesign of existing products is given somewhat more attention than the development of those new products which represent a radical departure from existing lines. The median percentage of outlays for industrial research among the companies included in the survey falls between 1.5 per cent and 2.0 per cent of the sales dollar. In a few instances, research costs run as high as 5.0 per cent of the sales dollar, while a minority of companies allocate very little or nothing to research and development. Most companies turn to outside research facilities for assistance.

★ ★ ★

THE RECIPROCATING steam locomotive was supreme on the American railroads from the beginning of the railroad industry. Early in this century the electrical engineers predicted that the steam locomotive was on its way out and would be very shortly supplanted by the electric locomotive receiving its power from trolleys, such power being produced either by large coal-burning central stations or, as is the case on our electrified divisions, from water power. While there is considerable mileage at present of electrified railroad operation, this prediction, of course, was not fulfilled. Without question, however, the supremacy of the reciprocating steam locomotive is now seriously challenged by the Diesel-electric. It appears further, however, that even with this new type of motive power, it will not have the same lack of competition as did the steam locomotive. Such competition will not be restricted to the coal-burning gas turbine locomotive . In sections where heavy fuel oil is abundant and relatively cheaper than coal because of transportation costs on the latter, the oil-burning gas turbine must be considered. Neither can we totally discount future possibilities of steam. A geared steam turbine locomotive is now in service on the Pennsylvania Railroad which, though somewhat limited in its application, has opened new avenues of thought. These include variations in the drive which would eliminate side rods, possible use of induced draft to reduce back pressure, possibilities of new boiler designs permitting higher pressures. There is, furthermore, now under construction a coal-burning steam turbine electric locomotive, which so far as its ability to haul cars is concerned, will have the same characteristics as a Diesel-electric of the same horsepower. As in the case of the gas-turbine, it is also true of any steam locomotive that it can burn the cheaper, heavier grades of fuel oil, a luxury as yet denied the Diesel engine—A. G. Hoppe, General Superintendent, Locomotive and Car Depts., Chicago, Milwaukee, St. Paul & Pacific R. R., before Midwest Power Conference, March 31, 1947.


ADSCO
PISTON-RING
Close-up showing location of piston rings
Note lubrication fitting
EXPANSION JOINTS
• In addition to the ability of ADSCO Expansion Joints to handle high pressures and temperatures, piston rings hold the line pressure, making it possible to add packing without shutting down the system. Write for Bulletin 35-15.
AMERICAN DISTRICT STEAM CO.
NORTH TONAWANDA N.Y.
MAKERS OF UP TO DATE STEAM LINE EQUIPMENT FOR OVER 65 YEARS

by this company is presented and the bulletin describes the features of this material also. How E. Baker Co.

MISCELLANEOUS

43 Clamping Tools and Fittings—Hose clamping, general maintenance and miscellaneous repairs with this manufacturer's clamp fittings are described in this recently-issued Catalog 235. The bulletin is excellently illustrated with line drawings which show how to make such repairs as clamping split handles, repairing cross arms, clamping guy wire guards, splicing welding cable and many others. Photographs also are used extensively. Punch-Lok Co.

44 Electric Chain Hoists—This recently published 8-page Bulletin H-100-A completely describes the company's line of electric chain hoists. The bulletin analyzes the need for hoists, shows how in 12 minutes per day operation of the hoist will pay for itself, describes the operation and gives complete specifications, speeds, prices, etc. for one-quarter, one-half and one ton hoists. Whiting Corp.

45 Filter Data Book—All types of oil filters are covered in this 24-page Bulletin 144. Oil filters for sludge removal, water removal, for use with motors and pumps and in turbine lubricating systems are described. Other filters and mixers for use in oil reclaiming and purifying units and for installation on tank trucks for fuel oil or gasoline delivery are shown. Blueprint illustrations show suggested pipe connections and control valve locations for filter mounting and method of installation. All types of filters are illustrated and a complete listing of outstanding features of construction and operation are given. Description of methods of acid formation, sludge removal and size of particles removed increase the usefulness of the bulletin. Alsop Engineering Corp.

46 Aftercoolers Bulletin—Bulletin L-802 is an 8-page catalog which describes the economical advantages of aftercoolers for removing moisture from gas or air lines before using in expensive tools and also for removing moisture from lines exposed to freezing. The bulletin is exceptionally well illustrated with charts and photos. Tables of approximate dimensions present more valuable information. Worthington Pump and Machinery Corp.

47 Combination Burners Data Book—Bulletin OB-PC presents complete engineering and operating data on the manufacturer's fuel-oil atomizers and ignition systems for pulverized coal burners. There are 32 pages and a separate heavy cover to this catalog and the blueprint illustrations are excellently designed to point out the features of construction and operation. Factors affecting operation and relative merits of various types of construction and operation are covered. Diagrams and explanatory matter covering baffling are included. The Engineer Co.

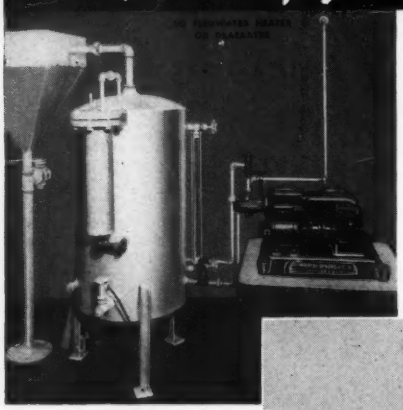
48 Speed Reducers, Transmissions—Bulletin 10,000 is a condensed catalog of the products, services and facilities of this company. Included in the description are precision gears, speed reducers, high speed drives, transmissions, special gear drives and many similar products. Each of these pieces of equipment included is described briefly and photographs are included. Details of construction of the company's steelflex couplings are given prominent display in the center of the booklet. Many drawings are included and construction features are covered fully. The Falk Corp.

49 Escalators—This 20-page booklet is written to and for prospective owners of Escalators. It is prepared in non-technical language and contains a brief history which tells of the many improvements made in the Escalator since the first model was shown in 1900. Several pages are devoted to location, maintenance and safety of escalators, photographs, drawings, and explanation of the driving mechanism and running gear; and a double page of photographs showing typical installations in such diverse structures as grandstands, railroad stations, restaurants, banks, factories, etc. Otis Elevator Co.

50 Plant Construction—This beautifully illustrated and prepared booklet (plastic bound in a heavy paper cover) illustrates the type of construction which this company has performed. Although this particular example is of an oil cycling plant the illustrations portray the excellent piping and detail work which has been accomplished. Construction of pump houses, aerator cooling towers, compressor houses and many other parts of a cycling plant are described in considerable detail. The center spread of the booklet is a 4-color illustration of the entire plant layout. The Fluor Corp.

50a Wire Rope Handbook—There are 170 pages in this manual and handbook on wire rope. Bulletin G-15 contains information on the internal lubrications of haulage, standard hoisting, flexible hoisting, non-rotating, aircraft and many other types of cable and rope. The front part of the booklet is crammed with information and photographic illustrations which illustrate effectively the information being presented. Sectional drawings of various types of cable are presented as are tables of diameter, weight per foot and breaking strength in tons. Another section of the book titled "General Information" gives instructions on how to properly order rope, arrangement of wires in the strand, grade of rope, capacity of drum of reels, safety factors, etc. Macwhyte Co.

Stop Oxygen Corrosion



with

% PROPORTIONEERS %

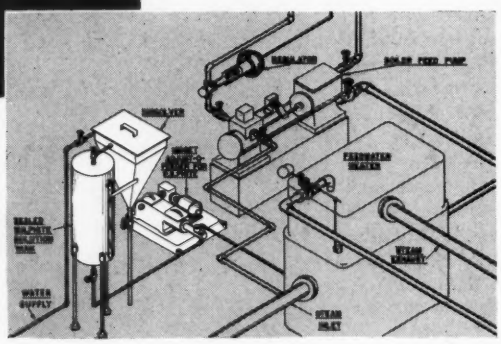
CONSTANT RATE INJECTIONS

to

FEEDWATER HEATER

or

DEAERATER



Protect EQUIPMENT

Save MAINTENANCE

Improve EFFICIENCY

%Proportioneers% feedwater treating equipment automatically applies sodium sulphite or other compounds to raw water makeup and condensate returns. Treatment is uniformly accurate and protects the piping system and boiler equipment from corrosion. %Proportioneers% offer standardized accessories and equipment for complete boiler water conditioning systems including equipment for internal treatment of boiler drums.

Ask us for Bulletin 1100 and installation drawings.

% PROPORTIONEERS, INC. %

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With greater emphasis being placed on increasing production . . . reducing down time . . . and cutting maintenance costs, more and more piping men are specifying Ladish Seamless Welding Fittings. They find the Ladish Ⓛ trademark on fittings good insurance for efficient, trouble-free piping operation.

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Please send me the handy 10-page data folder giving dimensions, weights and part numbers of Ladish Seamless Welding Fittings.

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This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions dictated by space requirement or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS

51 Steam Generators—Catalog almost completely devoted to cross-sectional drawings with accompanying listing of principal data of typical installations in rubber companies, steel works, sugar refineries, municipal plants, etc. Details of furnace water wall construction on inside back cover; 16 pages. Henry Vogt Machine Co., Inc.

52 Double-Pass Boilers—Bulletin RM-1 (6th edition); illustrates and describes this line of riveted or welded double-pass steel firebox boilers. Three full pages of dimensions, ratings and other details including dimensioned line diagrams; 8 pages. The Brownell Co.

53 Boilers, Burners, Accessories—bulletin GC-10; condensed catalog of regular products for stationary power plants. Each class of equipment summarized and illustrated. Well illustrated with line drawings and photographs. Illustrations accompanied by brief descriptions; 12 pages. Combustion Engineering Co., Inc.

54 Standardized Boilers—Bulletin 746; 4 page bulletin presenting construction and operation information and ordering specifications for this company's Type M boilers. Bulletin illustrated, presents table of measurement and data. Springfield Boiler Co.

55 Steam Generators—Presents reasons for high efficiency; shows brief case histories of plants. Results of tests by independent authorities and "Facts You Should Know About Steam Generating Units." Ratings, dimensions and other data presented. Springfield Boiler Co.

56 Steam Generator—Bulletin 119; company's Type S steam generator described and features of construction are pointed out. Folder well illustrated and dimensioned drawing and table of dimensions and sizes given. Union Iron Works.

PRIME MOVERS

57 Axial Flow Impulse Turbine—Bulletin S-107; six types described; data for estimates; applications; types, casings; wheels and blades; shafts, nozzles and bearings; overspeed stop and other governor features; lubrication; 8 pages. Terry Steam Turbine Co.

58 Multi-Stage Turbine—Bulletin SR-114; Casing, lagging, wheels and blades; shafts, nozzles, bearings; governors; speed changer or synchronizer; governor valve and steam strainer; lubrication; general; 10 pages. The Terry Steam Turbine Co.

59 Turbines, Pumps, Products—This 24-page catalog covers the company's complete line of products from steam turbines to flexible couplings. Every product is discussed from the design and operation angles and the discussion is heightened in interest by the inclusion of many excellent photographs. Other products discussed are helical gears, centrifugal pumps, multistage pumps, screw pumps, blowers, compressors and speed reducers. De Laval Steam Turbine Co.

60 Turbine Cleaning Manual—This 20-page bulletin covers the step-by-step solvent and manual cleaning of turbines from the inspection and preliminary cleaning to draining and final inspection. The cleaning of bearings and governor, installation of filter unit, circulation of cleaning solvent, and displacement of cleaning oil with new lubricating oil are steps which are covered briefly but clearly. Shell Oil Company, Inc.

61 Steam Engines—Bulletin No. 306; Engineering data; tabular material, descriptions; 8 pages. Troy Engine & Machine Co.

62 Generating Sets—Bulletin No. 108; General descriptions, typical installations, engineering data tables, details of construction, completely illustrated; 24 pages. Troy Engine & Machine Co.

63 Stationary Diesel Engines—Dependability, adaptability of Diesel power described and applications pointed out. Its economical and simple design is stressed. Advantages of company's equipment brought out; exceptionally well illustrated; 24 pages. Enterprise Engine and Foundry Co.

ELECTRICAL

64 Oil Circuit Breakers—Bulletin 71B-6421 describes Unitop oil circuit breaker; ratings from 15 to 46 kv, 500,000

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3. **Has given us the world's highest standard of living.**

Power Plant Engineering

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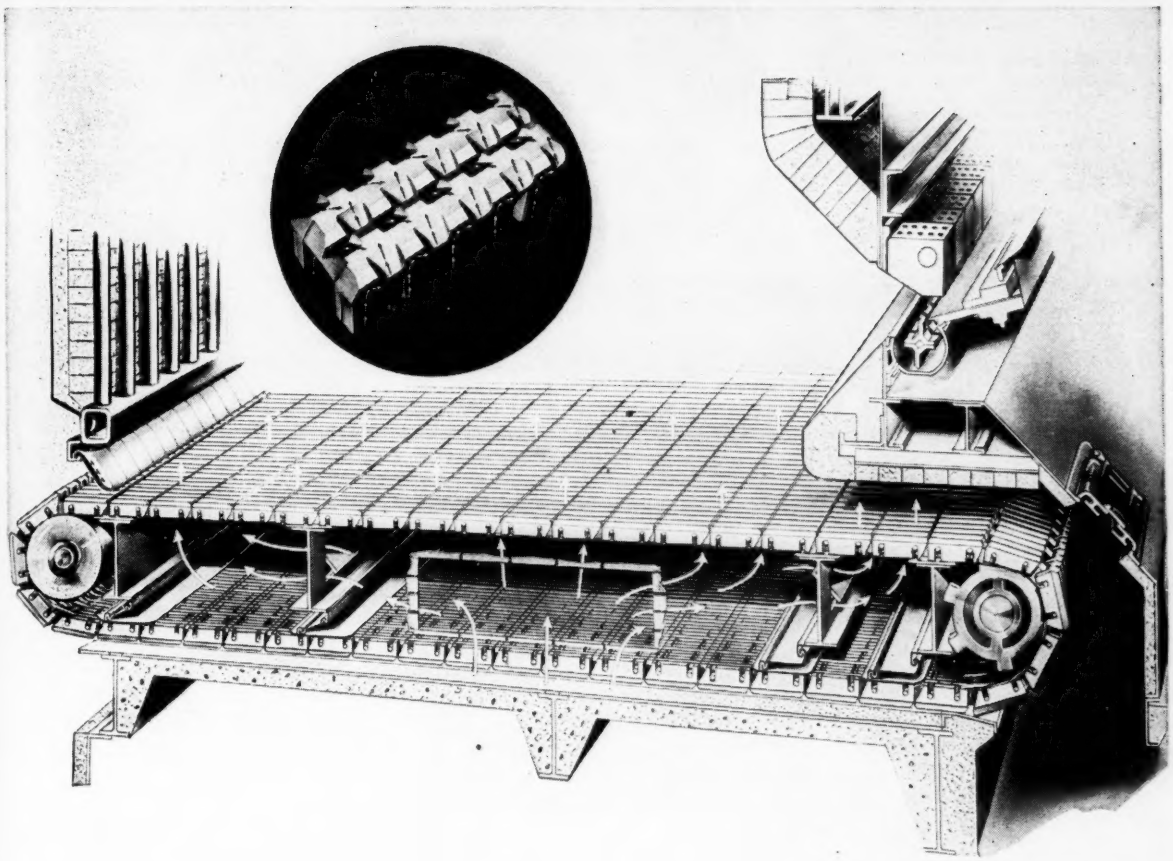

Bros Travl-Spred Stoker—Designed for Efficiency

Economical combustion depends upon fuel feed, fuel burning, air control, and ash disposal. The *Bros* Travl-Spred stoker performs all these functions with highest efficiency.

Uniform fuel distribution over zoned burning areas, controlled air turbulance from the *Bros* tuyere type grate, and continuous ash discharge assure more steam output at less cost. Air from the forced draft fan is discharged to the center compartment of the stoker where most of the burning takes place and where, by damper arrangement, air is admitted at lesser pressure under complete control as to quantity, to the pre-burning section in the rear and to the burn-down zone in front.

Individual tuyere units, like that shown in insert, form the grate surface. Note how the air is accurately metered.

A compact hydraulic drive keeps the grate traveling in continuous forward motion, maintains the reliable operation of the *Bros* Travl-Spred stoker. Write for further information. Wm. *Bros* Boiler and Manufacturing Co., Minneapolis 14, Minnesota.

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WATER TUBE, FIRE TUBE BOILERS • OVER FEED, UNDER FEED • HYDRAULIC-TRAVL-SPRED STOKERS

to 1,500,000 kva interrupting capacity. Well illustrated. Allis-Chalmers Mfg. Co.

65 **Generating, Substation Equipment**—Bulletin 25B6150 titled "More Power to U.S.A." 32 pages; sketches coverage of the company's equipment from hydro and steam turbines to switchgear and circuit breakers. Unusually well illustrated. Allis-Chalmers Mfg. Co.

AUXILIARIES, ACCESSORIES

66 **Strainers and Separators**—Bulletin 46-50; describes complete line of company's strainers and separators. Dimensioned drawings and photographs; tables of sizes and complete description of applications, operation and design; 16 pages. American District Steam Co.

67 **Atomizing Deaerators**—Bulletin 4160; 3 color drawing illustrates description of principle of operation. Advantages of deaerators are described and illustrated; marine deaerators also covered; 20 pages. Cochrane Corp.

68 **Steam Condensers**—Bulletin 1461 "Steam Condensers"; exceptionally well illustrated with line drawings, charts and photographs. Large proportion of the catalog devoted to engineering information such as calculations of required surface, atmospheric relief valve sizes, tube characteristics, free dry air leakage, pressure-temperature conversion tables and tables of logarithms; 46 pages. C. H. Wheeler Mfg. Co.

69 **Condensate Return System**—Description of operation and possible savings accompanied by line diagram and description of how "Jet-Loop" works; typical installation pictured and described. Drawings and text show proven results from experience of users. 2 page spread of drawings and table of dimensions; 16 pages. Cochrane Corp.

70 **Low Pressure Evaporators**—Description of L. P. evaporators; types of evaporator plants, listing of advantages of L. P. submerged tube evaporators. Line diagrams illustrate principles brought out in descriptions. Typical installations are considered and analyzed; 12 pages. Condenser Service and Engineering Co., Inc.

71 **Power and Industrial Equipment**—Bulletin Q-12; describes and illustrates company's equipment for power and industrial use—steam turbines, motors, generators, feedwater heaters, turbochargers, steam jet ejectors, centrifugal blowers. Exceptionally well illustrated; 20 pages. Elliott Co.

72 **Heat Exchanger**—This new bulletin describes the company's Twin G-Fin Section; Bulletin 1614; section characterized as universal heat exchanger. Bulletin tabulates 21 features and corresponding advantages, describes design and construction. Installation views shown, field reports included; 16 pages. The Griscom-Russell Co.

73 **Evaporators**—Bulletin 364 describes, illustrates evaporators for various capacities and pressures; contains sections of special interest to plant engineers and executives; includes explanation of functions of evaporators, benefits obtained by their use; different types of evaporating systems and their association with plant heat balance. 26 pages. The Griscom-Russell Co.

74 **Soot Blowers**—Bulletin F45; soot blowers in general are described. Description and operation of units, materials and specifications and other pertinent information is presented; tables of steam consumption, boiler efficiency, fuel saving chart; boiler cross-sections with blower locations indicated thereon and installation drawings and data are included; 10 pages. Marion Machine, Foundry & Supply Co.

75 **Water Heater Capacity Ratings**—14 tables are included in this ratings booklet showing capacity ratings per hour for temperature rises of from 20 deg (50 to 70 deg) up to and including ratings for a 150 F temperature rise (50 to 200 F). Table No. 15 presents the rate of flow of steam through pipes with steam from an initial gage pressure of one pound up to 150 psi. Marion Machine, Foundry and Supply Co.

76 **Heat Exchangers, Preheaters, Condensers**—A series of seven catalog sheets deal with various types of heat transfer equipment such as surface condensers, steam jet ejectors, heat exchangers, heaters and preheaters and coolers. Each of the sheets is well illustrated. Ross Heater & Mfg. Co., Inc.

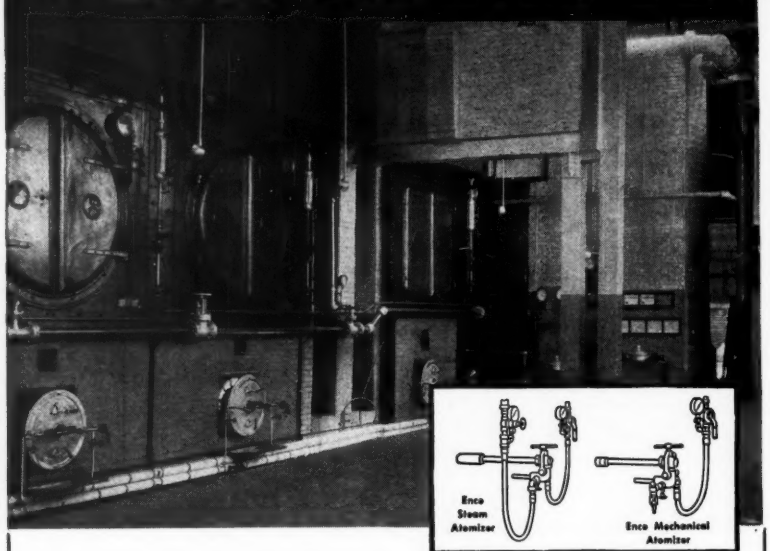
77 **Air Ejectors**—Bulletin M-300 and M-301; what they do; types, blueprint type drawings, tables of sizes, manufacturing facilities and equipment; total 16 pages. The Lummus Co.

78 **Coal Weighing Scales**—Description; outstanding features, specifications, line drawings, photos; 4 pages. Beaumont Birch Co.

79 **Rack and Pinion Gates for Coal and Ashes**—Ball-Bearing, dust-tight features; photos, specifications, drawings, tables of dimensions; 4 pages. Beaumont Birch Co.

80 **Steam Specialties**—Collection of folders; steam trap, air trap, reducing valves, classes E, B and H pump governors, automatic boiler feedwater controller; parts and unit list prices;

Swinging Load Demands are Easily Met with **ENCO OIL BURNERS**



In power plants where steam demands swing from high peaks to low loads over short periods, burner tip changes often become a nuisance to the engineer . . . and a source of man-hour loss which soon shows up in over-all cost figures.

With Enco Wide Range Atomizers, this frequent changing of burner tips is eliminated.

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For 30 years, Enco Burners have been leading the way to more efficient, more economical boiler operation. Write today for further information, or see your local Enco Representative.

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First the Manometer precisely measures the rate of flow. Then the Taylor Square Root Integrator accurately *totalizes* the flow of liquids, and of gases and steam under constant pressure. For instance, this versatile Taylor instrument keeps the exact total of steam consumption throughout your building at your fingertips.

The Square Root Integrator is easy to read through a large (2-inch) window in the case door. Dependable, synchronous motor drives counter thru positive clutch without the use of ratchets. Continuous check on accuracy of calibration at any point of range. Both Oilite and ball bearings for long life. Few moving parts; permanently lubricated cam rollers, self-lubricated bushings; positive, oil-proof counter clutch.

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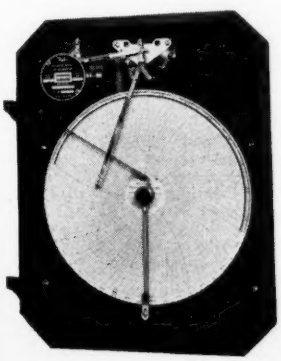
For full details, ask your Taylor Field Engineer. Also ask him about the new Taylor Aneroid (mercury-less) Manometer, with no mercury, no pivots, no stuffing box! Nothing to replace or wear out. Write for Catalog 98175. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.



Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

Taylor Instruments
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ACCURACY FIRST
IN HOME AND INDUSTRY

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descriptions; illustrations; tables of capacities. The C. E. Squires Co.

81 **Deaeration**—Data book; No. N-15 gives reasons for and principles of deaeration; cold water deaeration; tabular drawing and chart material presented; well illustrated; 20 pages. Elliott Co.

82 **Power Plant, Industrial Process Equipment**—Steam turbines, turbine generators; mechanical drive turbines; motors and generators; feed-water heaters and deaerators; condensers and auxiliaries; steam jet ejectors, centrifugal blowers; turbochargers for diesels; accessories and tube cleaners; completely illustrated; 20 pages. Elliott Company.

83 **How to Choose a Steam Trap**—Trap selection, trap rating, trap capacity factors, individual trapping, determining lift; traps for unit heaters, pipe coils, fan system heating surfaces, steam jacketed kettles, autoclaves, laundry equipment, paper makers, etc.; installation, operation, maintenance, instructions; specifications and capacities; corrosive service; 42 pages. The V. D. Anderson Co.

84 **Coal Pulverizers**—4-page bulletin covers pertinent points of construction of direct-connected pulverizer. Well illustrated; operating advantages presented. The Strong-Scott Mfg. Co.

WATER TREATMENT

85 **Index for Calcium Carbonate**—Reprint of paper by John W. Ryznar; tables and charts; 16 pages. National Aluminate Corp.

86 **Boiler Feedwater Q & A**—Bulletin 30; 102 questions and answers on various problems of boiler feedwater; 16 pages. National Aluminate Corp.

87 **Water Treatment**—Scale and corrosion control in potable water supply; reprinted paper presented by Hanlon, Steffen, Rohlich and Kessler; 12 pages. National Aluminate Corp.

88 **Water Conditioning Service**—"The 6 Fundamentals of Betz Water Conditioning Service" illustrates and describes how this company extends a supervisory service for boiler water conditioning. Booklet shows complete operation of these 6 steps; 16 pages. W. H. & L. D. Betz.

89 **Water Softeners**—Bulletin 607; benefits and economies of soft water; typical applications; how it works; types; design and features; backwash and brine rinse reguators; how to modernize present softener; aerators, degasitors, chemical feed systems, chemicals; 20 pages. Elgin Softener Corp.

90 **Softener Handbook**—Manual, semi- and full-automatic zeolite water softeners are covered in Bulletin 315. Water softener plant is discussed in the first section and operating cycles and plant supervision is next considered. The third section is "Selecting Manual or Automatic Equipment"; this is accompanied by a table of comparison data. Graver Tank & Mfg. Co., Inc.

91 **Sludge Reactivator**—Illustrated booklet, 8 pages, fully explains the principle of upward sludge filtration and describes its adaptability to industrial and municipal water supplies. Charts, flow diagrams and cut-away drawings show clearly how equipment softens and clarifies raw water, materially reduces reaction time and provides, in many cases, a water that is suitable for process work without further treatment. Graver Tank & Mfg. Co., Inc.

92 **Hot Process Water Treatment**—Form 326 is a case study bulletin; covers results of an installation of the company's hot process equipment at Kankakee Ordnance Plant. System was designed to provide 60,000 gph of properly conditioned water, free from hardness, scale forming minerals and corrosive gases. Graver Tank & Mfg Co., Inc.

93 **Water Treatment**—Control of Fouling Organisms in Fresh and Salt Water, by John G. Dobson. Life history of these organisms; method of control. Wallace & Tiernan Products, Inc.

94 **Industrial Water Treatment**—Microbiological Control of and Through Industrial Waters; spot summaries of improvement of process efficiency and product quality by proper sterilization. Wallace and Tiernan Products, Inc.

95 **Condenser Water Treatment**—Chlorination of Condenser Cooling Water, by R. B. Martin; important considerations in chemical treatment of cooling water circuits. Wallace & Tiernan Products, Inc.

96 **Water Treatment**—Chlorine Destroys Ammonia, by A. E. Griffin. Gives data on use of chlorine for elimination of ammonia from boiler feed water. Wallace & Tiernan Products, Inc.

97 **Clarifying and Softening Water**—Eight-page catalog "Reactivator for Clarifying and Softening Water by Upward Sludge Filtration." First part of the booklet tells how the reactivator works and how the sludge blanket is kept in control so as not to flow out with the clarified water. Line diagrams illustrate the principle of operation. Graver Tank & Mfg. Co., Inc.

98 **Feed Water Treatment**—This four-page folder tells how the company's

A TAYLOR WATER ANALYZER

will give you

These Desirable Advantages

- *Convenient* ... Eliminates use of fragile Nessler tubes and handling of individual standards.
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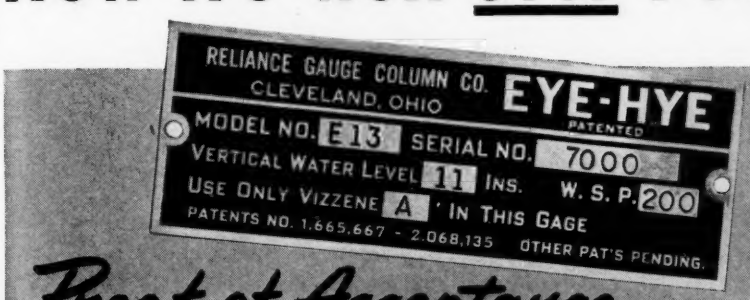
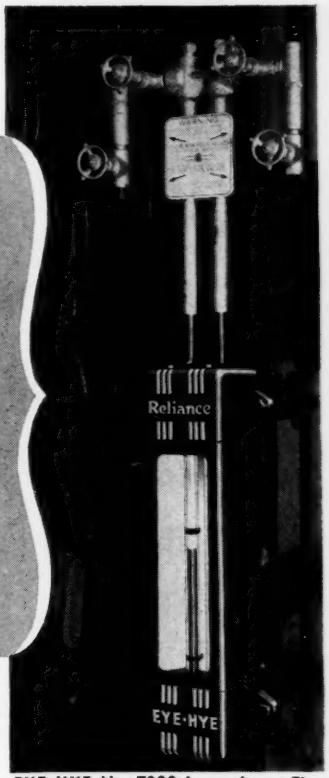
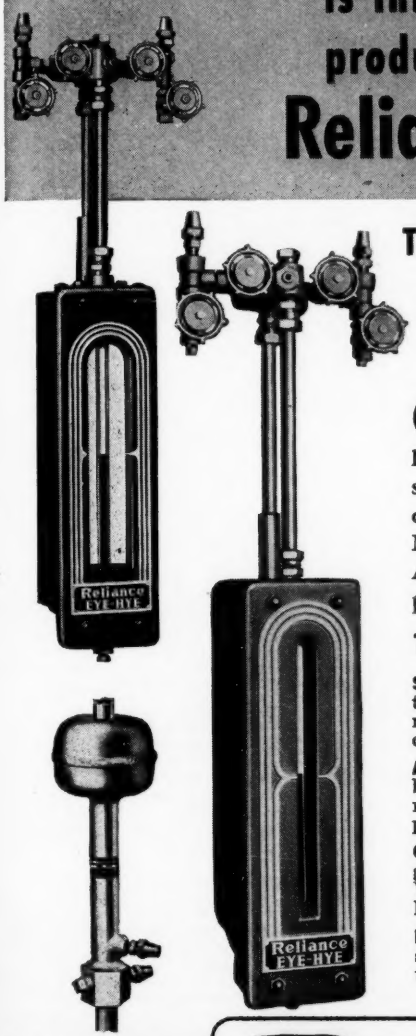


Proof of Acceptance

is this milestone in the production progress of Reliance EYE-HYE



EYE-HYE No. 7000 in service at The Pfieffer Brewing Co., Detroit, Michigan.



The original all-hydrostatic remote-reading water level indicator

One way you can be sure you are right in ordering EYE-HYE Remote Reading Gage equipment for your boilers is to consider its long record of satisfactory performance in all types of power plants—stationary and marine—ten years of constant acceptance growth—over 7000 placed in service. We celebrate the installation of EYE-HYE No. 7000 merely because it represents a milestone—a round figure. Actually, hundreds more have been shipped and are on order. The present modern design models are shown at the left.

The reasons for EYE-HYE's wide acceptance are many:

Simplicity: Based on the scientific U-tube principle—all-hydrostatic, with no complicated mechanisms to adjust or get out of order.

Accuracy: Full range accuracy assured by Reliance Unitemp—constant head reservoir which compensates for temperature variation.

Clear Indication: Reads like water gages you've always known, only *better*. Water indication in illuminated green liquid, *more visible* than water.

Flexibility of Placement: Can be installed any reasonable distance from the drum, either *below* or *above* it.

Easy to Install: Two lines of tubing can follow most convenient route between drum and EYE-HYE location.

Models for all Pressures: From lowest pressures (even at vacuum) to as high as 2500 lbs. Valuable for all types of auxiliary boilers and tanks.

Convenient Mounting: Can be placed on instrument panel board or any convenient wall or support.

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For outstanding safety and accuracy in water level reading... depend on EYE-HYE

BOILER SAFETY DEVICES since 1884

Reliance

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engineering applied to boiler feed water problems can result in savings. It tells of the different procedures and presents diagrams of equipment arrangement. Typical installations in dairy, cosmetic, aircraft, laundry, and other plants are pictured. Illinois Water Treatment Co.

99 **Chemical Feeding and Proportioning**—Bulletins 1100 and 1713A; use of adjustable chemical feeder for water treating, sewage, chemical processes, petroleum; plan and sectional diagrams; descriptions; photos; general specifications; 2-page table of capacity schedules; list of chemicals handled; accessories; drawings of boiler water conditioning systems; 5-page description of method of automatic intermittent feed of conditioning chemicals direct to the boilers; 20 pages. Proportioneers, Inc.

100 **Automatic Proportioning**—Bulletin 1200, 28 pages. Handy reference book containing wealth of information on automatic flow responsive equipment and methods in continuous process operation. Photos of equipment and installation are supplemented by many flow diagrams and detail drawings. Complicated subject made exceptionally clear and understandable by careful arrangement and two-color diagrams. Proportioneers, Inc.

101 **Chemical Proportioning Equipment**—Bulletin 1714 covers chemical proportioning equipment for sea-going service. Two units—for high or low pressure—are described fully. Tabular material assists in the description. Proportioneers, Inc.

102 **Water Conditioning Instruction Booklet**—Bulletin 28X6385 was written especially for guidance of power plant operators. It touches upon importance of feedwater control, care of testing equipment, obtaining samples, test procedures. Handy reference tables given as aid to reporting results. Allis-Chalmers Mfg. Co.

103 **Complete Water Conditioning Service**—This four-page bulletin describes this company's complete water conditioning service—analysis, design, fabrication, installation and maintenance of water treating equipment. Typical installations are pictured and brief sketches of the men behind the service are given. Graver Tank & Mfg. Co., Inc.

COATINGS, TREATMENT

104 **Protective Coatings**—4-page folder 844-246 describes Bitumastic Hi-Heat Gray, a specialized industrial protective coating which is said to resist corrosion and temperature up to 1200 F. The folder is in 2 colors and contains several photographs of equipment on which Bitumastic has been applied. It also gives a list of uses for the material and a chart giving its characteristics. Wailes Dove-Hermiston Corp.

105 **Fuel Oil Treatment**—A 4-page bulletin, telling about the company's treatment for fuel oil called "No Sludge." Advantages of using the treatment such as stepping up efficiency and reducing operating costs are explained. A list of dosages and applications is also given. A free test offer of the treatment is explained on the first page of the bulletin. Dominion Chemical Co., Inc.

106 **Flue Cleaner**—The company's soot and fire scale removing compound is described in this six-page folder. Results obtained from the use of this compound are described in the first part of the folder and then a list of the things which the company guarantees the material will accomplish are listed. Tables of dosage are presented and another table shows losses due to soot and fire scale. Dominion Chemical Co., Inc.

107 **Boiler Rust Treatment**—This four-page bulletin describes the company's "Rustoff" chemical which is said to "build resistance to rust and scale corroded and congested pipes." The bulletin tells how the treatment works and what results may be expected from its use. A brief description of the company's service department is included. Dominion Chemical Co., Inc.

108 **Fuel Oil Treatment**—Several bulletins have recently been announced by this company describing completely the application and effect of its fuel oil treatment compound and Diesel engine solvents. Wilcolene Mfg. Co.

HEATING, COOLING

109 **Cooling, Heating, Air Conditioning**—Collection of bulletins; installation, design, construction data, capacity ranges, condensed physical data; numerous photos of installations, full page color diagrams of flow of air, compressed air, water, water spray, etc. Niagara Blower Co.

INSULATION

110 **Industrial Insulations**—Block, blanket insulations; pipe covering; new pressure coverings; insulating cement; felt; Koldboard; fill insulation; diatomaceous earth products; uses, specifications, applications, preparation; charts; photos; list prices; 26 pages. Baldwin-Hill Co.

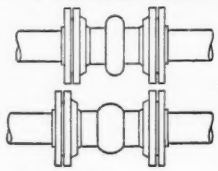
111 **Insulating Cement**—Ease of application; efficiency; ease of maintenance; application recommendations; heat loss calculations; 4 pages. Baldwin-Hill Co.

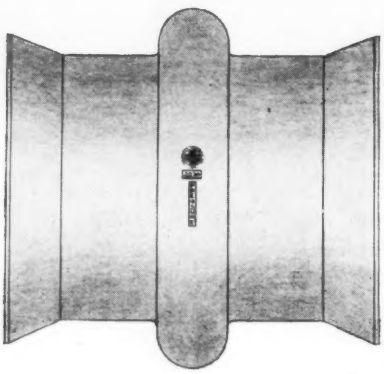
STOKERS

112 **Air-Cooled Stoker**—Catalog R-A; features of construction; how timing device works; installation drawings,

Note the Advantages of GOODALL

EXPANSION JOINTS With "FLANG-LOK" Ends





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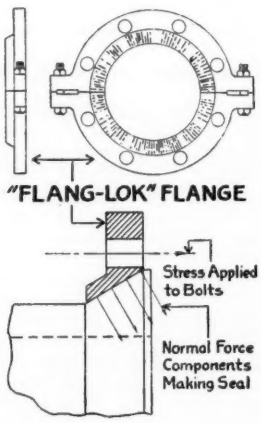

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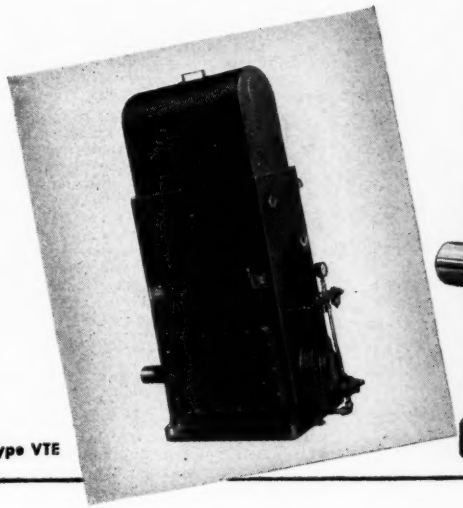

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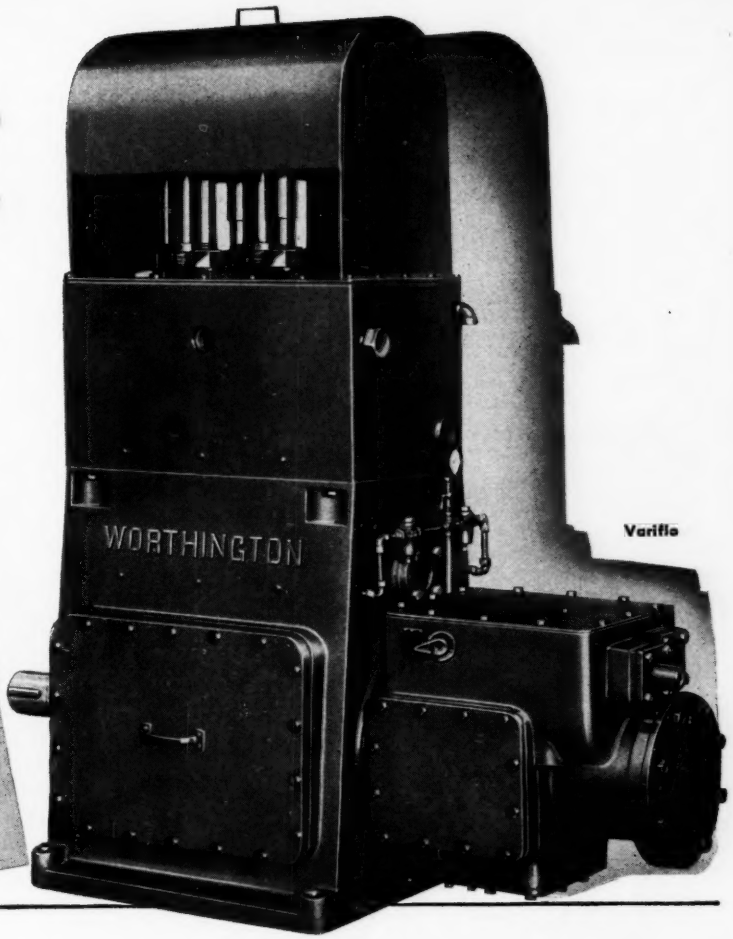

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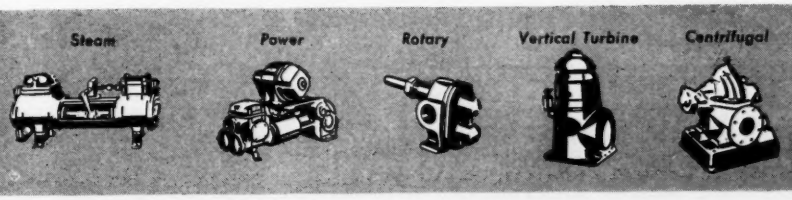

ash discharge, air cooling features; features of front end driving mechanism; engineering data tables; 20 tables. American Engineering Co.

113 **Water-Cooled Stoker**—Catalog W; drawings aof installations; features; furnace views; 8 pages. American Engineering Co.

114 **Spreader Stoker** — Installation views; features of various parts; cross-sectional view of furnace with installation; listed features; 8 pages. American Engineering Co.

115 **Pneumatic Spreader Stoker**—Threefold booklet on the inner pages of which there are 30 spirally-bound vertical pages which fold back to tell the story of the stoker, installation, features, construction, principles, engineering, types and models, typical installations; well illustrated; 33 pages. Iron Fireman Mfg. Co.

116 **Poweram Stoker**—Bulletin 7121; essentials of successful stoker; fuel control, fuel conveying, fan capacity, controls, installation; illustrations; 18 pages. Iron Fireman Mfg. Co.

117 **Coal Reference Bulletin**—Bulletin 8, Underfeed Stoker Firing. Bulletin covers factors involved in selection of multiple retort stokers, principles, design data and drawings of typical installations; 6 pages. Fairmont Coal Bureau.

118 **Stoker Firing Operation**—Single Retort Underfeed Stoker Firing is the subject of Bulletin Number 9 issued by this Bureau. It is a complete analysis of the advantages of the single retort stoker in the smaller plants. Types of this stoker are described and principles of operation are outlined. Fairmont Coal Bureau.

OIL, GAS BURNERS

119 **Wide Range Oil Burning System**—Bulletin 109; How the system operates; control, drawings; 4 pages. Peabody Engineering Corp.

120 **Oil Burners**—Bulletin 108; Two types of oil burners, A and H; air registers, oil atomizers, drawings; 4 pages. Peabody Engineering Corp.

121 **Gas Burners**—Bulletin 203; description of A and H gas burners; cross-sectional diagram; photos of atomizers; 4 pages. Peabody Engineering Corp.

OIL, LUBRICATION

122 **Lubrication Recommendations** — Special oils for diesels and heavy-duty gasoline engines; facts about oil; tables of recommended oils for various models; 18 pages. Standard Oil Company of California.

123 **Cutting Fluids**—Facts about cutting fluids; machine tool operations; fundamentals of cutting; how to apply; metallic cutting tools; tabular material; show practices; 50 pages. Standard Oil Company of California.

124 **Diesel Operation**—Relation of fuels and lubricants in the operating efficiency in the diesel engine; diesel fundamentals; maintenance; lubrication and fuels; supercharging; selection and classification of fuels; fuel injection maintenance; improving cleanliness; tabular material, charts, formulas; 114 pages. The Texas Co.

125 **Engineers Report on Oil**—Engine tests, laboratory tests, effects on engines, bearing corrosion, actual service data, filter clogging, service experience; well illustrated with photos and charts; 42 pages. Standard Oil Company of California.

126 **Lubricants Service Handbook**—28 pages in this booklet on lubricants and their application. The development of the lubricant, its features and advantages and the manner in which it meets various operating conditions take up the fore part of the booklet. "Recommendations" section where the manufacturer tells just what grease or oil should be used according to speeds, temperatures, pressures and general service conditions is given. Fiske Brothers Refining Co.

127 **Oil Products for Industry**—Cutting oil, processing oils, general lubricants, refrigeration oils, Diesel oils, solvents, greases and waxes are among the petroleum products for industry which are described in this four-page folder. The various grades of each oil are analyzed and the reasons why they are fitted to each particular job are given. Sun Oil Co.

128 **Lubricania**—The hundreds of specialized lubricants in use today are identified by certain commonly used tests and terms which describe their physical characteristics. In this dictionary of terms, tests and values, the company has highlighted the most important of these. Tide Water Associated Oil Co.

POWER TRANSMISSION

129 **Speed Reduction, Increase Gear**—Bulletin S-130; description; gear cases; gear and pinion; bearings; lubrication; drawings and photos; 8 pages. The Terry Steam Turbine Co.

130 **V-Belt Drive Guide**—Bulletin B605-1F; guide to company's complete line of V-belt drives. Contents include types and sizes. V-belt prices, how to

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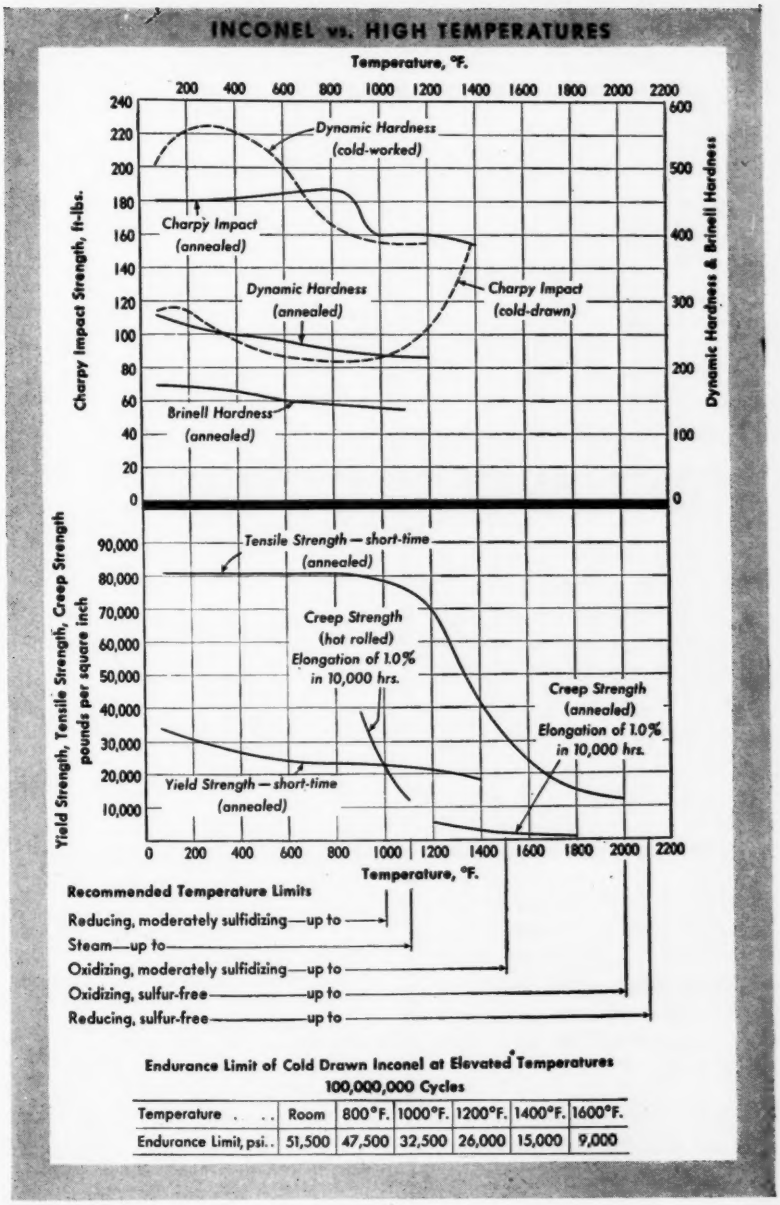
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Temperature, °F.
200 400 600 800 1000 1200 1400 1600 1800 2000 2200
Charpy Impact Strength, ft-lbs.
Dynamic Hardness & Brinell Hardness
Dynamic Hardness (cold-worked)
Charpy Impact (annealed)
Dynamic Hardness (annealed)
Charpy Impact (cold-drawn)
Brinell Hardness (annealed)
Yield Strength, Tensile Strength, Creep Strength pounds per square inch
Tensile Strength — short-time (annealed)
Creep Strength (hot rolled) Elongation of 1.0% in 10,000 hrs.
Creep Strength (annealed) Elongation of 1.0% in 10,000 hrs.
Yield Strength — short-time (annealed)
Temperature, °F.
Recommended Temperature Limits
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Steam—up to
Oxidizing, moderately sulfidizing—up to
Oxidizing, sulfur-free—up to
Reducing, sulfur-free—up to

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100,000,000 Cycles

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figure drives, belt selector charts and tables and similar engineering information. Well illustrated; 12 pages. Allis-Chalmers Mfg. Co.

131 **Chains and Sprockets** — Bulletin D-1; 2 color digest catalog, profusely illustrated, gives pertinent information on drive and conveying chains and sprockets, finished steel roller chains and sprockets, silent chains and sprockets, flexible couplings. Tables of numbers and pitches are given as are full page tables of list prices, dimensions and weights; 16 pages. Union Chain & Mfg. Co.

132 **Flexible Couplings**—Bulletin 57; 2 pages of drawings and tables of ratings for company's flexible couplings. Installations are shown and features of the various types are discussed; 20 pages. John Waldron Corp.

VALVES

133 **Regulating Valves**—Bulletin 1-A; valve data book, description, dimensions and lists of parts; typcial installations, rated capacities; prices; 52 pages. Atlas Valve Co.

134 **Pressure Regulator**—Bulletin 1-B; description, installation, operation; list prices; sectional and installation views; parts lists; 8 pages. Atlas Valve Co.

135 **Pressure Reducing Valves** — Bulletin 1-C; sectional drawings, list prices, dimensions and weights; operation and adjustment; capacities for steam and air; 12 pages. Atlas Valve Co.

136 **Corrosion Resistant Valves**—Two bulletins, both of them on corrosion resistant valves have just been issued. One of them, a techincal information bulletin covers the mechanical properties, analysis range, applications, advantages and sizes and specifications of the valves. The other is devoted to a photographic display of the installation of the valves. Alloy Steel Products Co.

137 **General Service Valves** — Bulletin E-150; valves for blow-off; fire protection, soot blower lines, acids, process etc.; descriptions; exploded views; features; dimensions, weights and list price tables; parts and parts lists; 14 pages. Everlasting Valve Co.

138 **Valves**—Bulletin E-100; for boiler room service; photos, descriptions, parts; features; pressure rating indexes; size shipping weight and price tables; ordering information; 30 pages. Everlasting Valve Co.

139 **Multiport Relief Valve**—Bulletin 4150; complete description of valves and operating characteristics, photographs of typical installations. Engineering data includes sizing information tables, nomenclature, installation and operation, list prices of accessories, dimensioned drawings and tables of dimensions; 28 pages. Cochrane Corp.

140 **Steel Valves**—Bulletin 102; 4 page bulletin describing company's "Evrtyte" valves. Cross-sectional illustrations and tables of seat orifice sizes, prices and dimensions are given; listing of features, description of the operation of the unit and parts and prices for assemblies. Strong, Carlisle & Hammond Co.

141 **Tube Compensators Data Book**—Specifications and data for installation of flexible tubing compensators; typical installations are shown in columns of line drawings. Compensating data chart for calculating required tubing lengths; tables of thermal expansion of pipe, etc. Chicago Metal Hose Corp.

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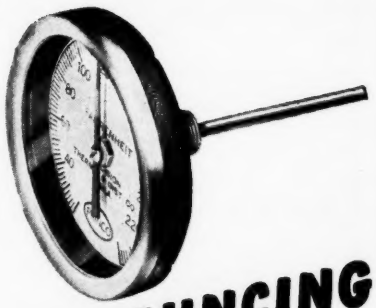

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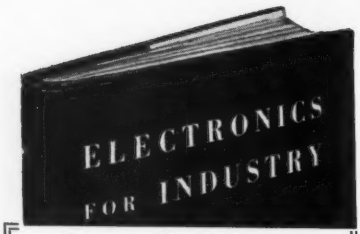

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143 71 Maintenance Jobs—This guide tells how better to perform commonly occurring power plant maintenance and cleaning operations. Illustrated manual gives specific material and method recommendations for handling cleaning, degreasing, descaling, derusting, paint stripping, etc. Booklet is completely indexed and reference is made by colored type strips on edge of the pages; 22 pages. Oakite Products, Inc.

144 Protecting Metal—High heat resistant coatings for protecting metal surfaces in power and processing equipment are covered in 4 page bulletin. Brief description of properties of coatings are given. The Dampney Co. of America.

145 Condenser Tube Inserts—Description of Flowrites; illustrated, accompanied by report of tests on Flowrites made by M.I.T. Tables and charts of test results are presented; description of how to install inserts given; 8 pages. Condenser Service & Engineering Co., Inc.

CONTROLS, METERS

146 Damper Regulators—Bulletin 4-A; for low pressure heating, medium pressure power and high pressure power boilers; what they do; how to specify; typical installations (drawings); adjustments; list prices; technical descriptions and parts lists; 20 pages. Atlas Valve Co.

147 Thermostats and Relays—Bulletin T, a 12-pg. catalog presents significant information on this company's mercurial thermostats and adjustable thermoregulators. Also included is complete data on relays, designed as companion instruments to the above mentioned. Complete descriptions of the instruments are included and the bulletin is well illustrated. Precision Thermometer & Instrument Co.

148 Recording Flow Meter—Bulletin 349; what it does, features, chart of rated capacity; construction and operation; installation drawings, tables of capacity; photos; 8 pages. Builders-Providence, Inc.

149 Propeller-Type Meter — Bulletin 350A; for main-line metering; applications, description, installation, materials of construction; features; table of capacity, shipping weights; specifications, drawings; 4 pages. Builders-Providence, Inc.

150 Water Works Controllers — Three models of venturi filter effluent controllers for water works are described in Bulletins 321B and 325A. The former is an 8-page bulletin; the latter has 4 pages. Features of the controllers—such as precise control, low loss of head, compact and flexible design and others are described and illustrated. Builders-Providence, Inc.

151 Centralized Combustion Control—Bulletin 43-605; applications to various types fuels and burning equipment; controller, measuring elements, pilot device, power unit, etc.; 24 pages. The Hays Corp.

152 Combustion Meters—Bulletin 44-550; reasons why it is accurate dependable, simple, rugged, easy to install, easy to maintain, speedy, easy to understand; well illustrated by explanatory diagrams; 16 pages. The Hays Corp.

153 Feedwater Textbook—"Mechanical Feedwater Regulation for Boilers" by Prof. E. P. Culver; principles of feed-

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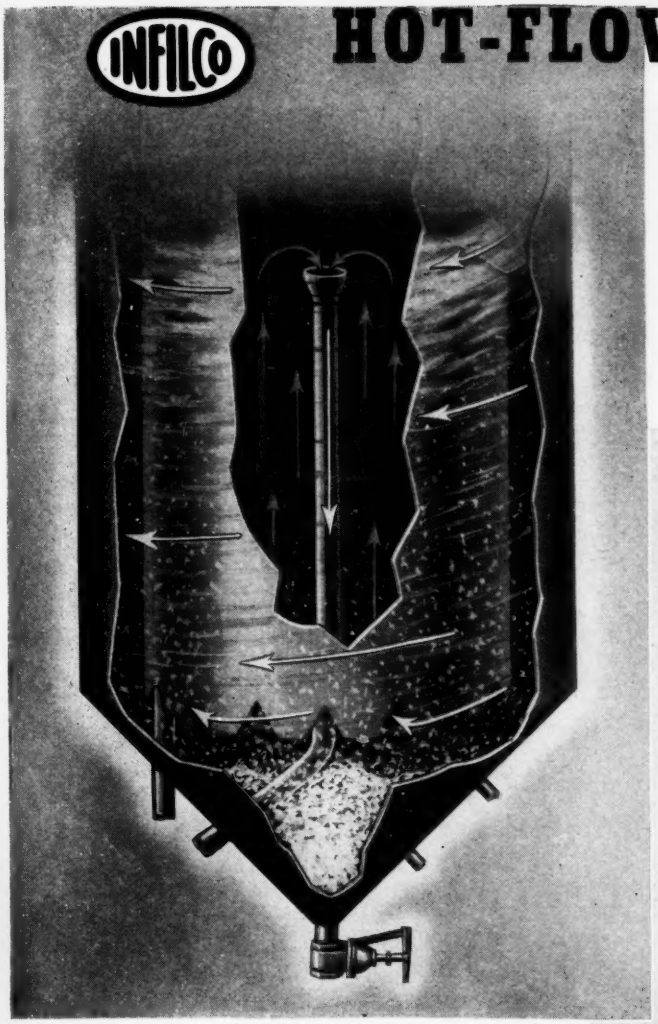

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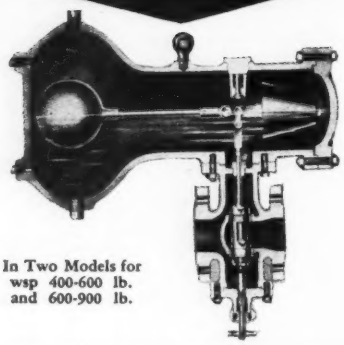

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water regulation; mechanical equipment available; differential pressure control; feed pump control; illustrations, diagrams, charts; 36 pages. Northern Equipment Co.

154 **Engineering Monographs** — Series of eight on automatic combustion control; 1. How Close Can Steam Pressure Be Controlled? 2. Why Operate Automatic Combustion Control from Changes in Steam Pressure? 3. Adapting to the Characteristics of Underfed Stokers. 4. Adapting to Spreader Type Stokers. 5. Adapting to Chain or Traveling Grate Stokers. 6. Adapting to the Characteristics of Pulverizers. 7. Adapting to the Characteristics of Oil Burners. 8. Adapting to the Characteristics of Gas Burners; total 37 pages. The Hays Corp.

155 **Draft Gages**—Bulletin 46-667; gages for indicating, recording of drafts, pressures, differentials, temperatures; pressure-draft tables; descriptions of equipment; differential units, Bourdon tube units, pointer gages, etc; 20 pages. The Hays Corp.

156 **Draft**—Bulletin 46-472; what draft is; where it is found; how it is measured; what the draft gage tells, where to measure draft and pressure in steam plant; where to connect draft gages; how to install; drawings; 20 pages. The Hays Corp.

157 **Flue Gas Analyzer**—Bulletin 45-668; principle of operation; construction features; technique; models and prices; Burrettes—classifications and uses (table); what flue gas analysis tells us; 16 pages. The Hays Corp.

158 **Indicating, Control Systems**—What they are, what they can do; Bulletin 14B6641. Description of how transmitter, receiver and indicator of systems are constructed, how they work, their advantages and specifications. Illustrated with photographs, diagrams, charts; 12 pages. Allis-Chalmers Mfg. Co.

159 **Water Gages**—Condensed catalog, Bulletin E, of company's complete line of water gages. Each model illustrated and accompanying table gives sizing information; 8 pages. Ernst Water Column & Gage Co.

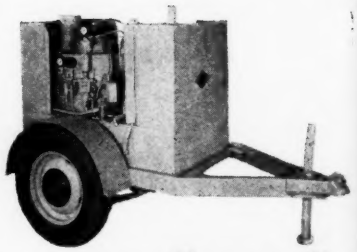
160 **Stainless Steel Bellows**—Bulletin SSB-46; contains diagrammatic cross-section views and up-to-date information concerning the use of these bellows as equalizers, compensators, expansion joints, flexible connectors for flow control, vapor and steam traps, Inc. Chicago Metal Hose Corp.

161 **Pitot Equipment**—Three section Bulletin 50; gives complete details of the use of Pitot tubes and rods, instructions in the use of the company's portable Pitot recorder, together with theory, formulae, notations and curves. Simplex Valve & Meter Co.

162 **Manometers** — Bulletin 200; describes completely this line of fixed and portable manometers for use in water surveys and similar flow rate measurement, valuable engineering data also included. Simplex Valve & Meter Co.

163 **Instruments, Controls for Process** —Bulletin 17; process controllers, control components, measuring components and instrument combinations briefly described and illustrated. Application data such as sizes, pressure standards and ranges are listed; 8 pages. Bailey Meter Co.

164 **Temperature Regulators**—Bulletin 7-A; six types; descriptions, list prices, tabular material, photos; list of parts; typical installation drawings;



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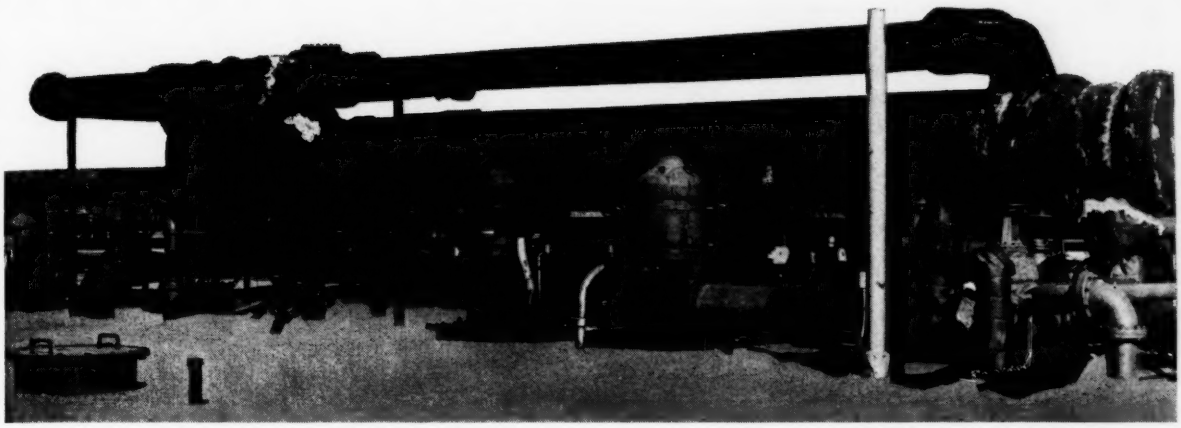

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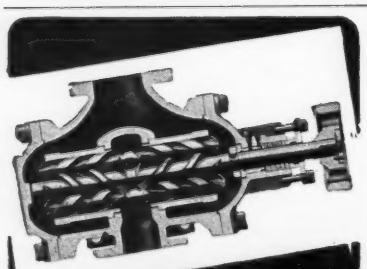

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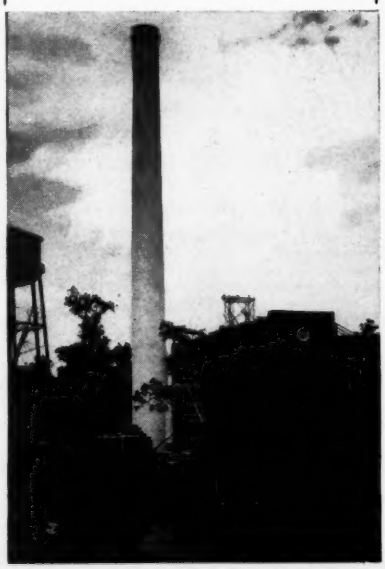

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tables for finding sizes of control valves required to heat given quantity of water; 16 pages. Atlas Valve Co.

165 **Draft, Excess Air and CO_2**—Bulletin 39-341; discussion of the relation of these elements to the installation and servicing of bituminous and anthracite stokers by Arnold Soller; 12 pages. The Hays Corp.

166 **Liquid Level Controllers**—Bulletin A-100 is a four-page catalog describing this company's Types G and D liquid level regulators. Excellent cross-sectional views of the units are presented and their operational and constructional features are described. Stets Company.

167 **Desuperheater**—Bulletin 405-A, 4 pages, pictures and describes the company's self-contained desuperheater. Specifications and charts of tests results given. Northern Equipment Co.

168 **B. F. Water Control**—Bulletin 441, 28 pages, describes boiler feed water control for high-duty boilers. Three-color illustrations depict operating principle. Characteristics and features, differential pressure control, dependability described. Completely illustrated with line drawings and reproductions of charts. Northern Equipment Co.

169 **Water Level Control**—Bulletin 445, "Controlling Water Level on 675 psi Boilers in Eastern Utility Plant." Well illustrated with photos and charts. Northern Equipment Co.

170 **F. W. Control**—Bulletin 447, 16 pages, describes "Feedwater Control for World's Largest Forced Circulation Boiler." Cross-sectional drawings, flow diagram, excellent photos, charts furnish illustrative material. Northern Equipment Co.

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171 **Packing**—Bulletin 237; photos and descriptions of use; installation drawings; standard size table; 4 pages. Warren Steam Pump Co., Inc.

FITTINGS

172 **Standards for Flanged Fittings, Valves, Flanges**—Pressure temperature ratings, tables and charts, rating procedure, flange materials, safety factors, loading, stress formulas; 20 pages. Tube Turns, Inc.

173 **Welding Fittings**—Allowable working pressures; power, oil, district heating, refrigeration, gas and air piping; 14 tables and directions for use; 18 pages. Tube Turns, Inc.

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175 **Unions**—Complete line of malleable iron unions and convenience unions; illustrations, descriptions, size and list prices; descriptions of materials and workmanship. Jefferson Union Co.

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176 **Horizontal Duplex Piston Pumps**—Bulletin 230-1; specifications, steam end, liquid end; capacity tables for pressure service, light pressure service; dimensions, drawing, tables; 4 pages. Warren Steam Pump Co., Inc.

177 **Steam Heat Vacuum Pumps**—Bulletin 226-1; specifications, drawings, general information, tables of sizes and capacities; 4 pages. Warren Steam Pump Co., Inc.

178 **Centrifugal Pumps**—Bulletin 302-30, Revised; instructions for installation and operation; drawings, tabular material; 12 pages. Warren Steam Pump Co., Inc.

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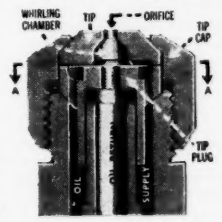

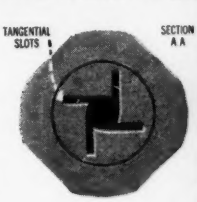

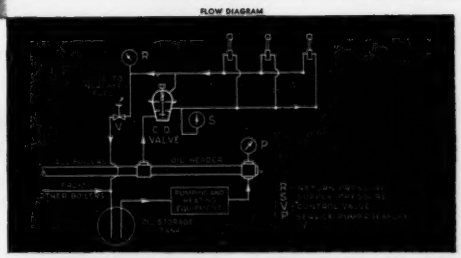

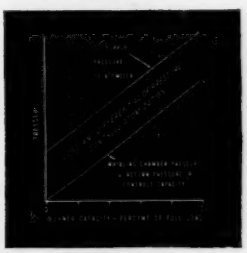

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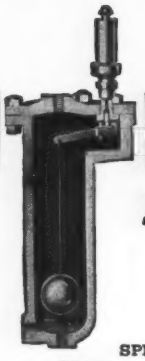

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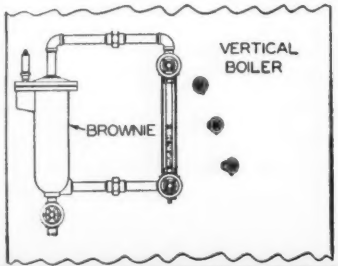

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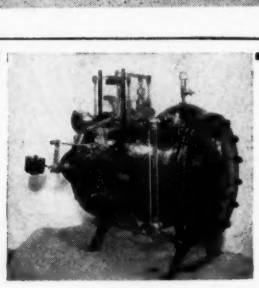

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of capacity, sizes, pipe sizes, pressure; 4 pages. Warren Steam Pump Co., Inc.

180 **Screw Pumps**—Recommended uses; advantages; tables of capacities and sizes; charts of test results; dimensioned drawings; suctions and discharge, packing box sizes, shipping weights tables; specifications; installation and maintenance; theoretical horsepowers. Sier-Bath Gear & Pump Co., Inc.

181 **Centrifugal Pumps**—Booklet describes basic action of centrifugal pumps, tells of the science of centrifugal action and the physics of pumping. Performance curves are presented. Descriptions of the company's self-priming centrifugal pumps are given and how they operate is explained. Marlow Pumps.

182 **Centrifugal Pumps**—Bulletin 240, 6-page folder describing single stage, double suction, Type DBL centrifugal pump. Features of the pump resulting from its construction and engineering; a sectional view which is used to point out other advantages of the unit. Warren Steam Pump Co., Inc.

183 **Multi-Stage Pumps**—Bulletin 241 describes 4 and 6 stage Type TM pumps. Cross-sectional illustrations and tables of specifications are given. Dimensioned drawings and tables of dimensions. Warren Steam Pump Co., Inc.

184 **Close-Coupled Pumps** — Close-coupled pumps, called Compae-units, are described in Bulletin 242. This eight-page bulletin presents clear and understandable cross-sectional photos of the units and uses these to point out construction and operation features. Warren Steam Pump Co., Inc.

MISCELLANEOUS

185 **Floor Resurfacing**—This recently-published folder describes the methods of use of the company's heavy-duty resurfacer for use on floors, traffic aisles and loading platforms. It contains a concise, clear description of the properties, methods of application and advantages of the resurfacer. Stonhard Co.

186 **Electric Tools**—Bulletin 464; covers complete line of portable electric tools for construction and briefly describes such tools as electric hammers, drills, chisels, vibrating tools, accessories, screw drivers, etc. Syntron Co.

187 **Refractory Concrete**—"Lumnite for Refractory Concrete"; basic information on materials and methods used in making refractory concrete. Illustrations show application of concrete in construction of furnaces, coke ovens, etc. Another section covers concrete use in foundations, floors and structures subject to high heat; 24 pages. Lumnite Division, Universal Atlas Cement Co.

188 **Gas Purger for Refrigeration System**—Bulletin 160; tells how to cut power costs and raise condenser capacity by proper purging of non-condensible gases. Tables of ammonia properties, advantages and complete illustrated material. Typical installations are pictured. Two pages with diagrams tell how purger operates; 8 pages. Armstrong Machine Works.

189 **Grinding Wheels**—Grinding wheels of various abrasives are illustrated and list prices presented; tables of sizes in inches are accompaniel by photographs and line drawings of these various wheels. Grinding wheel dressers with list prices are shown; 32 pages. Norton Co.

190 **Weldments**—Bulletin SP106, tells about the services of this company's weldry and the weldments turned out therein. The products of this weldry are shown and the text points out how flexible the method is by showing that it makes no difference if the finished product is constructed of light sheet or heavy metal . . . the resulting product can be made to exacting specifications. Graver Tank & Mfg. Co., Inc.

191 **Drop Forged Flanges**—Manufacturing processes; physical characteristics; full-page tables of illustrations, dimensions, weights and prices. Space provided for future insertions. Phoenix Mfg. Co.

New ENGINEERING BOOKS

Diesel Operation and Maintenance, by Orville L. Adams; 366 pages; illustrated; size 6½ by 9½ inches; cloth binding; Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, New York; price $5.00.

It is the objective of this book to cover every problem of Diesel engine operation and maintenance. It is a completely new treatment by an author who is a Diesel engineer, a technical writer and a teacher. His previous book, Modern Diesel Engine Practice, published in 1931, was an outstanding work on the subject at that time; but many details of operation and equipment have changed materially during recent years, hence an entirely new book on operation and maintenance is now required.

This new book covers clearly and concisely the basic principles and procedures, the methods and techniques of maintenance and repair of Diesel engines. Much emphasis is placed upon the fundamental operating principles and the origin of all major engine problems is identified and traced back to the fundamental principles.

The book covers standard maintenance and repair practices, together with standard inspection methods and techniques now used in the maintenance of pistons, liners, rings and bearings. Guides to trouble shooting contain instructions on diagnosing fuel oil and lubricating problems, determining the causes of engine failures and breakage of parts. Numerous questions and problems at the end of each chapter bring out the salient points.

The book is suitable for courses of study in vocational schools, technical institutes and training classes and for the use of practical Diesel operating men. It employs no higher mathematics but is filled with tables, charts and whatever simple arithmetical calculations are required. Illustrations of engine parts show clearly the important construction details, and forms are given for records of engine operation, repairs, inspection and maintenance history.

The book is recommended to anyone concerned with the operation and maintenance of Diesel engines. It stresses the importance of preventive maintenance, good standard operating practice and skillful maintenance methods.

The book begins with a discussion of fundamental problems, the advantages and disadvantages of the Diesel engine, fuel economy, fundamental principles of operation and discussion of types. Subsequent chapters deal with: problems of application, basic problems of operation, metallurgical problems, the fuel mixing problems and the basic maintenance problems. Following these come chapters on inspection procedure, piston ring maintenance and inspection, piston and liner maintenance, bearing failures and maintenance problems, problems of lubrication, fuel oil and combustion problems. At the end there is a metallurgical glossary, tables and formulas, lubricating oil specifications. The book is well indexed.

Steam Power Stations by Gustaf A. Gaffert, Third Edition, 613 pages, illustrated, size 6½ by 9½ inches, cloth binding, published by McGraw-Hill Book Co., 330 West 42nd Street, New York 18, price $5.50.

The author, a member of the famous consulting engineering firm of Sargent and Lundy, wrote this book originally to serve as a concise and practical textbook on steam power stations. It was based on his background of several years of teaching experience in heat power engineering courses, followed by several years in the field of mechanical design of steam power stations. In adidtion to its wide use as a textbook in college engineering courses, it has been found very useful by many practicing power engineers.

It presents in order the construction, performance characteristics and finally the integration of major and minor steam power

(*Continued on page 192*)

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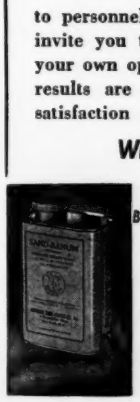

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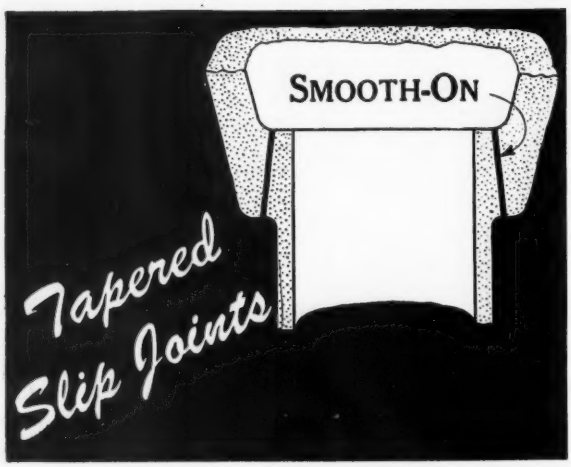

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POWER PLANT *Construction News*

Ark., Pine Bluff—Arkansas Power & Light Co., Pine Bluff, has concluded arrangements for acquisition of partially constructed steam-electric generating station of Government at Lake Catherine for a reported consideration of about $925,000, and will take over at early date. Company will proceed with construction and plans installation of turbine-generators, high-pressure boilers and other facilities for rating of about 80,000-kw. Entire project is estimated to cost close to $7,500,000, including transmission lines.

Calif., Cresta—Pacific Power & Light Co., San Francisco, Calif., plans new hydroelectric generating station on North Fork of Feather River, vicinity of Cresta, with power dam, generating station, switching station and other facilities. Plant will be equipped with hydraulic turbines, electric generators and accessories for rating of close to 150,000-hp, and will represent an estimated investment of approximately $25,000,000. This is one of several such plants projected by company on same river.

Conn., Bridgeport—Bridgeport Brass Co., 30 Grand St., metal products, has plans under way for new boiler house at plant, reported to cost close to $150,000, with boilers and auxiliary equipment. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Ind., Muncie—Indiana General Service Div., Indiana & Michigan Electric Co., Muncie, plans new power substation in downtown district, estimated to cost over $375,000, with transformers, switchgear and auxiliary equipment. Work is expected to be placed under way during summer.

Iowa, Council Bluffs—St. Bernard's Hospital, Frank and Harmony Sts., care of John Latenser & Sons, 1305 Farnam St., Omaha, Neb., architects, plans early construction of new multi-story boiler house for central-heating service at institution. Cost reported over $100,000, with boilers and accessories. Work is scheduled to proceed at early date.

Iowa, Waverly—Town Council has plans for extensions and improvements in municipal power plant. Capacity will be increased. No estimate of cost announced. Stanley Engineering Co., Hershey Bldg., Muscatine, Iowa, is consulting engineer.

La., New Orleans—Lone Star Cement Corp., 2315 France St., plans installation of electric power equipment in connection with expansion and improvements in mill. Additional buildings will be erected and machinery installed for large increased capacity. Entire project estimated to cost close to $1,000,000. Proposed to begin work soon.

Md., Baltimore—Consolidated General Electric Light & Power Co., Lexington, Bldg., plans new power substation at 2507 Evergreen Ave., reported to cost over $100,000, with transformers, switchgear and other facilities. Erection will begin at early date.

Mich., Calumet—Calumet & Hecla Consolidated Copper Co., Calumet, plans extensions and improvements in steam-electric power plant at Lake Linden. A new boiler unit, using pulverized fuel, will be installed. Project is expected to require about 24 months for completion. No estimate of cost announced. Vern E. Alden Co., 120 South LaSalle St., Chicago, Ill., is consulting engineer.

Mich., Petoskey—City Council plans new municipal power plant using Diesel engine-generating units and accessories, to supplement service from present hydroelectric power station. Cost estimated about $500,000. A special election is expected to be held in June to vote bonds in that amount for project.

Minn., Austin—George A. Hormel & Co., meat packers, plans new boiler house at plant. Cost reported over $60,000, with boiler units and accessory equipment. CPA has approved project.

Minn., St. James—Northern States Power Co., Minneapolis, Minn., has plans maturing for new generating station at St. James, with capacity of about 2000-kw using Diesel engine-generating units and auxiliaries. Cost estimated about $200,000. Work will be carried out this summer.

Minn., Tracy—Northern States Power Co., Minneapolis, Minn., plans new power plant in vicinity of Tracy for auxiliary service, with installation to include two Diesel engine-generator units, each with rating of about 1000-kw,

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company "Bridgeport" *Headquarters for BRASS, BRONZE, and COPPER*

Effect of Water Composition on Condenser Tube Life

"Which condenser tube alloy is best suited to my operating conditions?" This is a leading question which is asked most frequently by power plant engineers.

The first considerations are operating conditions—type of water, water composition, velocity, temperature, extent of contamination, foreign matter, etc. Since all of these factors have a direct bearing on corrosion or tube life, we must choose an alloy which will best resist the corrosive conditions existing at the particular plant in question.

The composition of the water plays an important part in selection of the most suitable copper-base alloy since the alloy and the water interact to form a corrosion film.

Effect of Water Composition on Corrosion Films

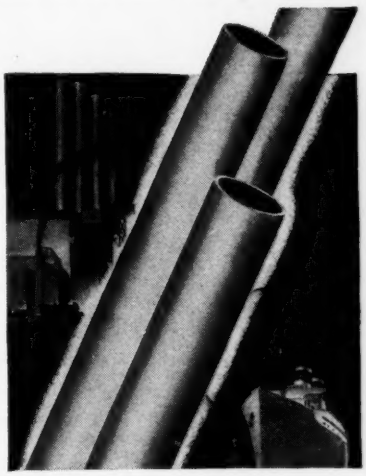
Under certain conditions these films tend to protect the metal and greatly slow up the rate of corrosion. For example, copper exposed to Lake Erie water developed a very thin, varnish-like protective film. On the other hand, the same copper exposed to fresh waters from certain wells and streams (in contact with calcium-rich mineral deposits) became covered with white to grayish-white or reddish colored calcium carbonate scale. This mineral-type scale is also highly protective to copper.

Copper exposed to sea water develops a green-colored film bonded to a red-colored film which in turn is attached to the copper. The outside green-colored film is composed of a mixture of copper salts, and the underlying red-colored film is essentially red cuprous oxide. This layer-type scale is characteristic of that found on copper which is undergoing a low but steady rate of corrosion. If the sea water contains a trace of hydrogen sulphide which results from decomposition of organic matter by bacterial action (0.5 or more parts per million), the green-colored film is changed into a black-colored copper sulphide-rich film and a marked increase in film thickness and corrosion rate results. Copper galvanically coupled with a less noble metal such as iron, steel, aluminum, magnesium, zinc, etc. under certain conditions or exposed to moderately high temperatures in sea water (for example, copper tubing in evaporators) will have formed on its surface white to grayish-white colored calcium-magnesium carbonate scales which are highly protective. This type of film is often objectionable because of its low heat transfer properties.

Effect of Alloy Composition

Alloy composition also plays an important part in the formation of protective films and consequently in the corrosion resistance of condenser and heat exchanger tubing. The addition to copper of such alloying elements as aluminum, zinc, iron, silicon, tin, arsenic and nickel results in alloys which have varying degrees of corrosion resistance under a wide range of conditions. Data in Tables I and II show how widely corrosion films and corrosion rates vary with the type of alloy and water composition.

No consistent rule can be laid down to correlate film formation with corrosion rate but certain trends can be detected. For example, as the film thickness increases on copper, Admiralty, and Duronze IV, the trend is toward higher corrosion rates. This does not hold true with alloys such as aluminum brass or 70-30 Cupro Nickel. It may be assumed that the presence of thin films (less than 200 milligrams per square decimeter) coincides with low corrosion rates—a conclusion which experience has verified time and again.



More Investigation Necessary

It is evident that much remains to be learned about the effect of water composition and alloy composition on corrosion films and corrosion rates. At the present time very little is being done about altering the composition of sea water used for cooling purposes, although fresh water is being treated in some cases. More information regarding the effect of water composition on condenser tube life will result from more extensive testing of different alloys under varying conditions, carried out through continued cooperation between power plant engineers, metallurgists, corrosion engineers and condenser tube manufacturers. Examination of condenser and heat exchanger tubing now in use as well as the installation of corrosion test panels and test lots of tubing will be extremely beneficial.

Contact the nearest Bridgeport office for assistance from laboratory trained men who are in a position to give power plant engineers information regarding Bridgeport's many condenser tube alloys. Also write for 112-page Condenser Tube Manual.

TABLE I

Weight of Corrosion Film in Milligrams Per Square Decimeter Obtained at 3 Test Sites (1–2 Years' Exposure)

Alloy	Lake Erie (Fresh Water)	Coast of South Carolina (Harbor Water)	Coast of North Carolina (Clean Sea Water)
Copper	105	...	750
Arsenical Admiralty	125	472	560
Arsenical Aluminum Brass	89	179	170
70-30 Cuoro Nickel (0.42% Fe)	175	148	81
Duronze IV	46	192	550

TABLE II

Depth of Corrosion of Several Copper-Base Alloys in Mils Per Year at 3 Test Sites (1–2 Years' Exposure)

Alloy	Lake Erie (Fresh Water)	Coast of South Carolina (Harbor Water)	Coast of North Carolina (Clean Sea Water)
Copper	0.114	....	1.50
Arsenical Admiralty	0.129	1.09	1.51
Arsenical Aluminum Brass	0.144	0.38	0.79
70-30 Cupro Nickel (0.42% Fe)	0.142	0.80	0.33
Duronze IV	0.165	0.58	1.16

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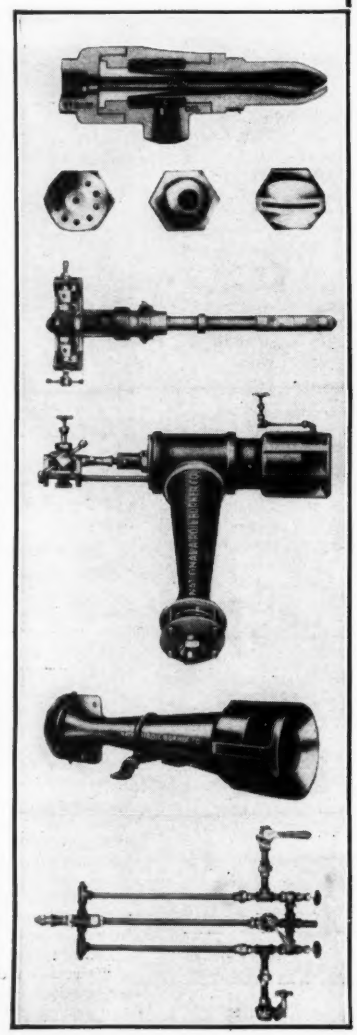
(Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors in combination with fuel oil.



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and auxiliary equipment. Proposed to carry out work in 60 to 90 days. Cost reported approximately $250,000.

N.Y., Syracuse—Niagara-Hudson Power Corp., Syracuse, is arranging a large expansion and improvement program in power plants and system in different parts of Northern New York, to be carried out over a five-year period, including new generating stations, power substations, transmission lines and distribution systems. Entire project will represent a gross expenditure of close to $100,000,000.

Ohio, Columbus—State Welfare Dept., Capitol Bldg., plans extensions and improvements in power plant at local Ohio State Penitentiary, with installation of new boiler, stoker and auxiliary equipment. No estimate of cost announced. Sims, Cornelius & Schooley, 2901 North High St., Columbus, are architects.

Pa., Aliquippa—Jones & Laughlin Steel Corp., 3rd and Ross Sts., Pittsburg, Pa., plans addition to mechanical blower and engine house at steel mill at Aliquippa, to cost close to $130,000, with equipment. Erection is scheduled to begin at early date.

Pa., Philadelphia—Container Corp. of America, Inc., Nixon and Fountain Sts., paper boxes and containers, has approved plans for expansion and improvements in power plant work at factory, and work will be carried out soon. Additional equipment will be installed. Cost reported close to $200,000. H. M. Wilson Co., 18th. and Brandywine Sts., Philadelphia, is engineer.

S.C., Charleston—South Carolina Power Co, Charleston, plans expansion in power plants and substations, with installation of equipment for increased capacity. Cost reported about $1,000,000. Work will be carried out in the near future.

Texas, Abilene—West Texas Utilities Co., Abilene, will have plans prepared by Sargent & Lundy, 140 South Dearborn St., Chicago, Ill., consulting engineers, for proposed expansion in local steam-electric generating station, recently referred to in these columns. Entire project will cost approximately $1,100,000, with equipment.

Texas, Penwell—Shell Oil Co., Inc., Shell Bldg., Houston, Tex., plans boiler house and compressor station in connection with proposed new natural gasoline plant in vicinity of Penwell (Ector County). Entire project is reported to cost over $2,500,000.

Texas, Shamrock—Phillips Petroleum Co., Bartlesville, Okla., and Shamrock Oil & Gas Co., Shamrock, associated, plan new pumping station for booster service on oil pipeline between Shamrock and Denver, Colo., estimated to cost about $125,000, with equipment. Another similar station will be constructed in vicinity of McKee, Tex., to cost about like amount.

Utah, Orem—Utah Power & Light Co., Salt Lake City, has plans under way for new steam-electric generating station at Orem, vicinity of Salt Lake City, with turbine-generators, high-pressure boilers and auxiliary equipment for an initial capacity of 40,000-kw. Entire development is estimated to cost over $5,000,000, including transmission lines for connection with present high-tension system.

Utah, Provo—Dept. of Utilities, 7 South University Ave., plans expansion and improvements in municipal steam-electric generating station, with installation of new 7500-kw turbine-generator and auxiliary equipment. Cost estimated close to $1,250,000. City engineer is in charge.

Va., Manassas—Prince William Electric Cooperative, Manassas, plans expansion in electric generating station, with installation of new 1000-kw Diesel engine-generator unit and auxiliary equipment. Financing has been arranged through Federal aid, and work is scheduled to be carried out soon.

Va., Millboro—B-A-R-C Electric Cooperative, Millboro, plans new hydroelectric generating station on site now being selected. Fund of $268,000 has been arranged through Federal aid to finance project, with portion of sum to be used for rural line construction.

Wash., Tacoma—St. Regis Paper Co., Tideflats, Tacoma, plans installation of electric power equipment in new addition to sulphate pulp mill on adjoining tract of land, comprising several large multi-story units. Entire project will represent reported investment of about $4,000,000. Main offices are at 230 Park Ave., New York, N.Y.

Wis., Bayfield—Northern Wisconsin Power Co., Bayfield, plans new hydroelectric generating station on Iron River, vicinity of Bayfield, at site to be developed as Orienta Falls dam. Cost estimated about $225,000, with equipment. Wisconsin Public Service Commission has approved project and work is expected to begin soon.

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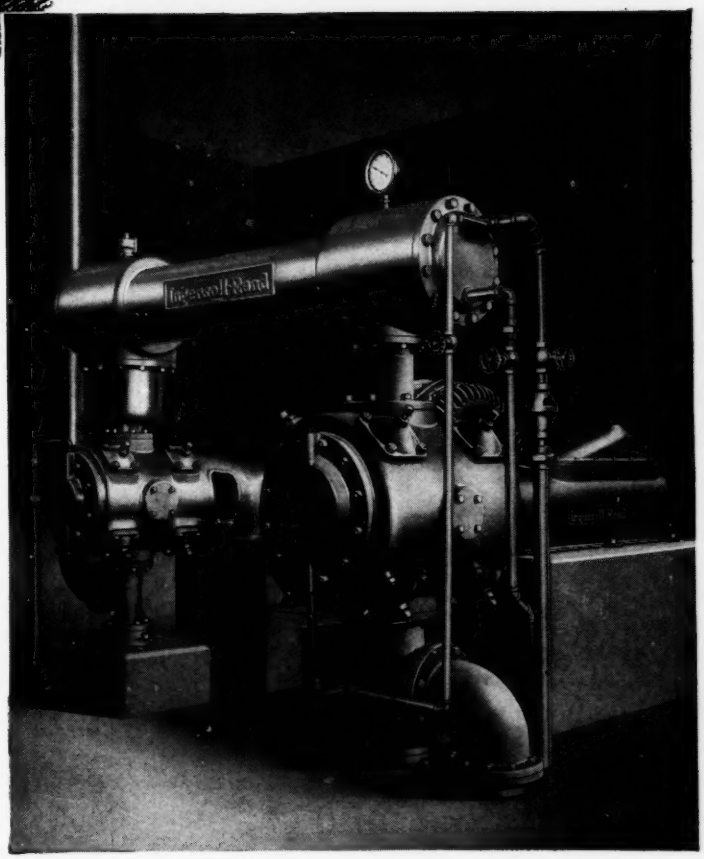

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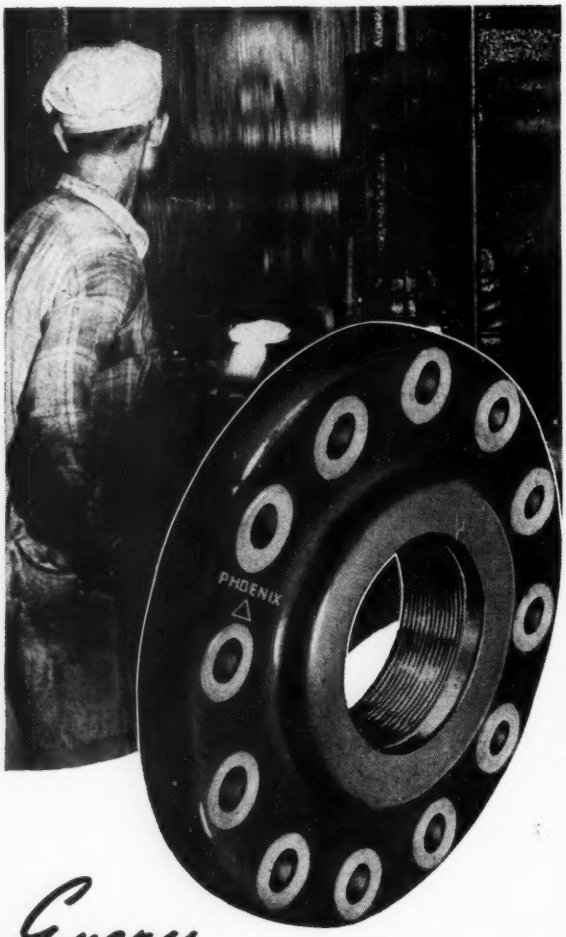

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ENGINEERS' PREVIEW

A COURSE in the History of the Scientific Idea has been given for the past 25 years at Goucher College. Its creator, Dr. Dorothy Stimson, reported that reaction of its graduates left no doubt as to the value of such a course in giving meaning to science in relation to the everyday experience of the average student. Conversely, it is necessary that the student in science or engineering be made aware of the philosophical and humanistic ideas behind our culture. Cornell University has already initiated a required course in the History of Science. With such courses in both liberal arts and engineering schools, educators hope to build a two-way bridge across the gap separating the "scientific barbarians" from the "ignorant humanists," says the ***Industrial Bulletin.***

★ ★ ★

SILTING of reservoirs behind dams is something every hydraulic engineer is conscious of whenever he has to do any work in connection with diversion dams, irrigation dams, power dams. The problem has many important physical and economic aspects. Silting of a power dam, for example, by affecting minimum regulated outflow, may decrease firm power and increase dump power with great loss of revenue. While most of the factors have been studied and evaluated in specific cases, the overall problem has not yet been attacked vigorously by engineers, despite the rapid rate of sedimentation in reservoirs throughout the country. In 1936, J. C. Stevens, in a paper before ASCE, emphasized the seriousness of the problem and the need for concerted action. During the past 25 years, many dams, small and extremely large, have been built for various purposes. If these become silted up, a natural resource is lost, for there is a limit to the storage available on any watershed. Today the public is aware of the problem. Foreign nations planning large projects are looking to America for the technical "know-how." The spotlight has been focused on the problem. It was laid before the spring meeting of the ASCE at Phoenix, Arizona by Wm. E. Corfitzen, special representative of the Bureau of Reclamation. He reported that members of the Subcommittee on Economic Effects of Reservoir Sedimentation have been exchanging ideas on the subject, stated that suggestions and ideas would be welcomed by the subcommittee and that work would go forward towards a satisfactory solution.

★ ★ ★

ALKYD RESIN paint made under U. S. Navy specification, has been found to be fire retardant. Once a fire started on board ship, layers of older paint help to spread the flames and also give off acrid fumes to hamper fire fighters. Sometimes paint would continue to burn after the source of heat had been controlled. Present Navy specifications for inside white paint call for 100 lb of antimony oxide per hundred gallons and an alkyd resin base. While such paints will not stop a fire, they will check the speed with which the flames spread. This has been a factor in many tragic flash fires. It should be of interest in hotels and industrial buildings and all places where decorative paints are used.

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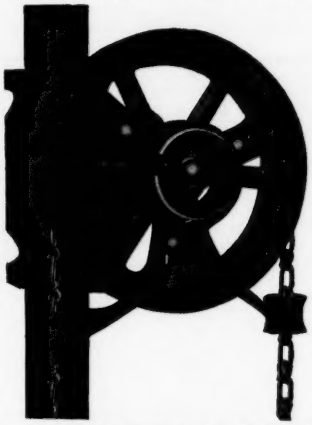

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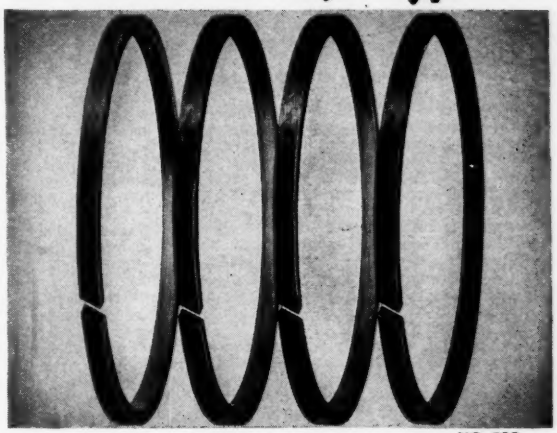

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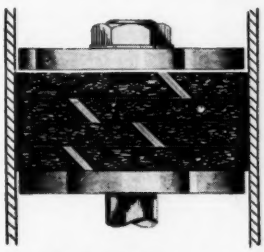

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NEW ENGINEERING BOOKS

(*Continued from page 185*)

plant machinery. The treatment begins with fundamentals and develops in a way that allows the practical man as well as the student to expand his knowledge progressively through the more difficult subjects to the complete integration of all the equipment in a power plant. No higher mathematics are required for understanding the book. It is copiously illustrated with diagrams, charts, curves and details of equipment. We highly recommend it to all power engineers as a fundamental textbook.

The present Third Edition differs little in general plan and arrangement from the previous two editions. However, in recent years, although fundamental principles have not changed at all, there have been developments in details of equipment and methods of employing it. These developments have been incorporated to bring the book strictly up to date on the present day applications of the fundamentals. Particularly valuable are the chapters on steam station costs, load curves and plant locations, selection of prime movers and equipment, cycle arrangements and station design.

The subject is covered under the following chapter headings: I—Introduction; II—Steam Engines; III—Steam Turbines; IV—Condensers; V—Feedwater Heaters and Evaporators; VI—Feedwater Treatment; VII—Fuels and Combustion; VIII—Steam-Generating Units; IX—High-Pressure and Binary-cycle Boilers; X—Dust Collectors; XI—Economizers and Air Heaters; XII—Superheaters and Reheaters; XIII—Fuel-burning Equipment; XIV—Duct Work and Piping; XV—Draft System; XVI—Coal and Ash Handling; XVII—Pumping Equipment; XVIII—Steam-Station Costs; XIV—Load Curves and Plant Location; XX—Selection of Prime Movers and Steam-Generating Equipment; XXI—Cycle Arrangement; XXII—Binary Vapor Cycles; XXIII—Optimum Cycle and Units; XXIV—Station Design.

The book is well indexed and is provided with a list of tables. At the end of each chapter are given a number of practical problems to test the reader's grasp of principles, and a list of authoritative references to books and articles giving further details on the subject of the chapter.

Van Nostrand's Scientific Encyclopedia; Second Edition; 1600 pages; illustrated; size 7½ by 10 inches; cloth bound; D. Van Nostrand & Co., Inc., 250 Fourth Avenue, New York City; price $12.00.

Following the general plan of the first edition of this volume, the second edition is designed to encompass in one book the basic sciences and the applied fields of science and engineering. In one volume it covers over 11,000 terms of scientific interest arranged alphabetically. To this edition, new sections have been added on electronics and radio, metallurgy, meteorology, photography and statistics. The sections on aeronautics, engineering, chemical, civil, mechanical and electrical, and navigation have been expanded considerably.

The entire book now takes into account the broad advances in science that have occurred in aeronautics, astronomy, botany, chemical engineering, chemistry, civil engineering, electrical engineering, electronics and radio, geology, mathematics, mechanical engineering, medicine, metallurgy, meteorology, mineralogy, navigation, photography, physics, statistics and zoology—in all, twenty sections.

Each science has been treated largely by a single author, in order to obtain unity. However, other scientists have worked with each primary author and a still larger group have acted in an advisory capacity.

An extensive system of cross-indexing has been developed for this encyclopedia to enable the reader to find all the facts bearing directly on each topic. In this system, terms explained elsewhere in the book are printed in bold face type wherever they are used in an important way in the course of the articles on other terms.

Each topic is developed progressively in the discussion, beginning with a simple definition expressed in the plainest terms and progressing to a final reflection of the more detailed scientific aspects of the topic treated. Some topics require several pages for their discussion, others only a short paragraph.

Manufacturing Processes by Myron L. Begeman; Second Edition; 626 pages; illustrated; size 6 by 8½ inches; Cloth binding; John Wiley & Sons, Inc., 440 Fourth Avenue, New York City; price $5.00.

During the past 5 years, American industry has demonstrated its ability to produce at rates beyond all previous conception. Many new materials, machines, tools and processes have been developed during that period by virtue of necessity and with the aid of intense research work. Consequently a knowledge of recent manufacturing processes is of extreme importance to engineers engaged in industry. With new processes a product can frequently be made in several ways and these should be known to the designer and production engineer. Possibilities and limitations of processes and tools should be understood if low factory costs are to be obtained.

The object of this book is to provide such information for training young engineers in the technical fundamentals of important processes, materials and tools. In this second edition, principal changes are made by adding new chapters on special casting methods, powder metallurgy, hot forming of metals and cold forming of metals. The chapter on plastic molding has been rewritten, also that on welding and allied processes. All chapters have some new material on the new methods and equipment.

The book is well illustrated and the detailed diagrams of machines and machine parts are especially valuable. Lists of references to articles and books are given at the end of each chapter, together with review questions. The book gives a comprehensive picture of present day manufacturing techniques in the field that it covers—the working of metals—

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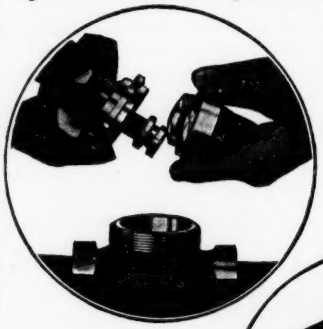

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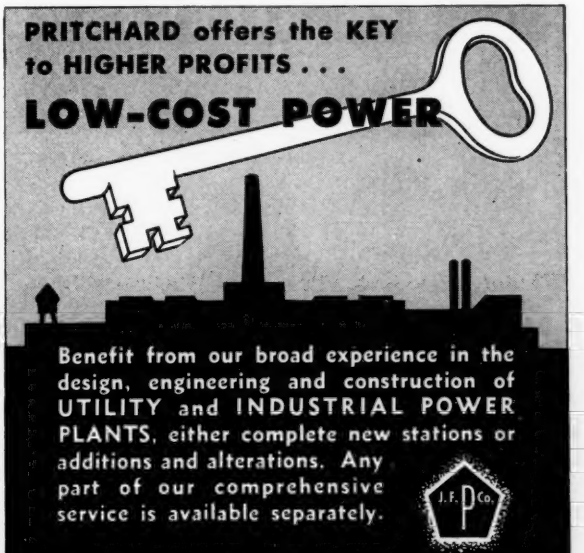

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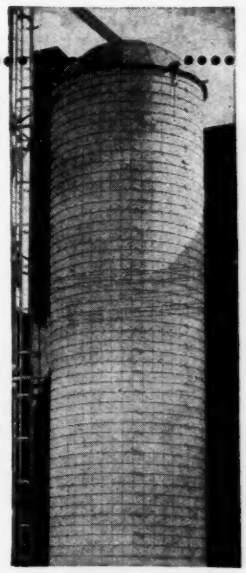

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The discussion is covered in the following chapter headings: Foundry Practice; Pattern Work; Metal Casting; Special Casting Methods; Plastic Molding; Heat Treatment of Steel; Powder Metallurgy; Welding and Allied Processes; Hot Forming of Metals; Cold Forming of Metals; Inspection-Measuring Instruments and Gages; Lathes and Lathe Tools; Threads and Thread Cutting; Shapers and Planers; Drilling and Boring Machines; Milling Machines and Cutters; Gears and Gear-Cutting Machines; Metal Sawing; Broaching Machines and Tools; Turret and Automatic Lathes; Abrasives, Grinding Wheels, and Grinding Machines.

A list of tables is given and the book is well indexed.

Mechanics of Materials by P. G. Laurson and W. J. Cox; Second Edition; 422 pages; illustrated; size 5½ by 8½ inches; cloth binding; Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York; price $4.00.

The new edition of this popular book was prepared to provide a clearer presentation of the subject matter while retaining the original concept of the first edition. That concept was that the ultimate purpose of a basic book on mechanics of materials is to prepare the user for an eventual clear understanding of machine and structural design.

This revision, accordingly, contains much reworking of earlier material, notably the following: Chapters on columns have been rewritten and re-arranged to simplify the subject; a discussion of Mohr's Circle has been added to the chapter on Restrained Beams; and data have been changed in all the problems that were retained. New material includes: method of superposition; triangular loading of continuous beams and continuous beams fixed at ends; centroids and moment of inertia of crosssections of sheet metal beams; and tables of deflection of beams.

The additions and revisions in this book should add appreciably to its already recognized value. Knowledge of higher mathematics is valuable for understanding some parts of the book; but, for the most part, the mathematics needed does not go beyond the solving of ordinary equations. Although the book is intended primarily for a text, it should be of value to practicing engineers in design of structures and machines.

The problems culminate in a group of comprehensive problems which form the final chapter. The solution of each of these requires the application of a number of principles drawn from different parts of the text.

The subject is discussed under the following chapter headings: Stress and Deformation; Mechanical Properties of Materials; Allowable Stresses; Stresses Due to Axial Loads; Riveted and Welded Joints; Torsional Stress, Shafts, and Helical Springs; Beams—Shear and Bending Moment; Stresses in Beams; Design of Beams; The Deflection of Statically Determinate Beams; Restrained Beams; Direct Stresses Combined with Bending; Columns With Axial Loads; Columns With Eccentric Loads; Combined Stresses; Elastic Energy, Stresses Produced by Moving Bodies; Continuous Beams; Beams of Two Materials; Beams (Additional Topics); Thick-Walled Cylinders Subject to Internal and External Pressure; Eccentrically Loaded Connections; Comprehensive Problems.

At the end is an appendix of Centroids of Areas, another on The Moment of Inertia of a Plane Area, and a third giving tables of standard beams and structural shapes, commercial measurement of lumber, pipe, screw threads, and a variety of other machine elements. The book is indexed.

Mathematics for Self Study, by J. E. Thompson; Series of 5 volumes covering in one volume each the subjects of Arithmetic, Algebra, Geometry, Trigonometry and Calculus; Second Edition; Approximately 280 to 325 pages per volume; illustrated; size 5½ by 8 inches; cloth binding; D. Van Nostrand Company, 250 Fourth Avenue, New York City; price $8.95 for five volumes.

Here is a series of books on mathematics, written especially for self-study at home without the aid of a teacher. They are intended also for use by those who wish to refresh their knowledge of the subjects. The emphasis throughout is on methods of studying the subject alone and on fundamental principles. These are clearly and simply explained without resorts to tricks. When legitimate short cuts and time-saving methods are well-tested and applicable, they are described, but for the most part the presentation is quite conventional.

The book on arithmetic begins with a short historical introduction and a discussion of numbers, then proceeds to the discussion of the fundamental operations of addition, subtraction, multiplication and division, calculation with decimals, etc. Chapter 4 is a very good discussion of approximate results in calculation, pointing out the practical reasons why they occur and why it is not necessary to be more accurate than the data of the problem being calculated. Good short cut methods of approximation are shown. Part II of the book, on Principles and Methods of Arithmetic, begins with factors, multiples and divisors, goes on to fractions, then takes up powers and roots and in a very logical way coordinates this with a chapter on logarithms and their use in arithmetic. Then follows a discussion of ratio and proportion, series and progression. Part III on Measurement discusses common systems, calculation with denominate numbers; time, temperature and angle measurement; latitude, longitude and time; dimension areas and volumes; Part IV gives special applications of arithmetic in graphs, percentage, compound interest, etc.

The book on Algebra begins with discussion of symbols and numbers of algebra; addition and subtraction; multiplication and division and factorization. Part II on Fundamental Principles covers powers and roots; laws of exponents; fractional exponents and radicals; imaginary and complex numbers; powers nd roots of binomials. In Part IV is detailed treatment of the principles of logarithms, systems and tables of logarithms, methods of calculation with them, and exponential equations. Part V deals with special subjects such as ratio, proportion and variation; progressions and series; combinations and probability.

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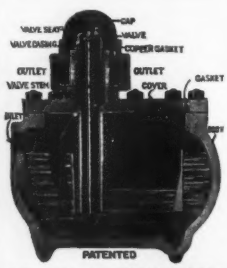

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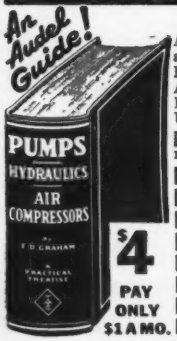

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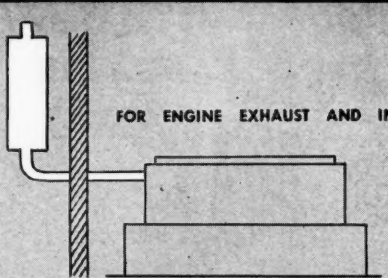

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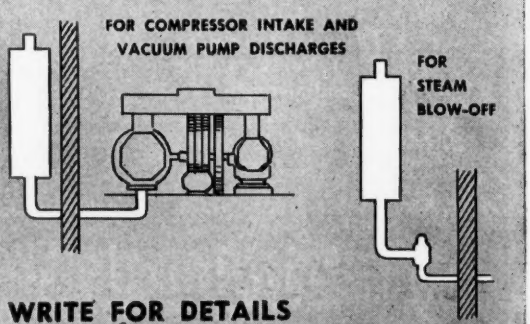

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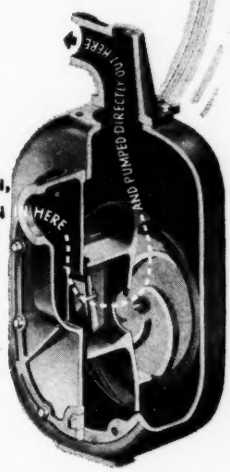

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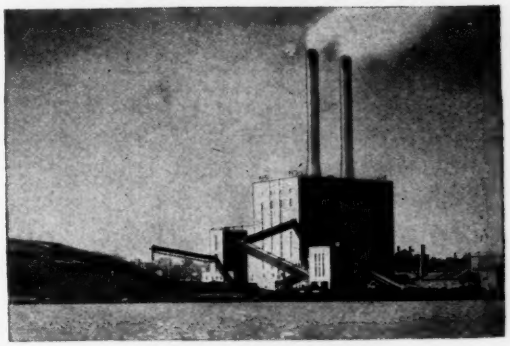

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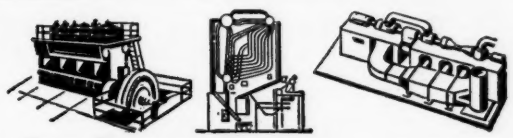

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phasis is laid on the symbols and methods of algebra as the basis for such subjects as geometry, trigonometry and calculus.

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The fourth volume is on Trigonometry, which differs from geometry primarily in being concerned with the measurement and numerical calculation of geometrical quantities. That is, it applies the mathematical shorthand of algebra to triangles and their geometrical properties and adapts them to numerical calculation for application and uses. Trigonometry is definitely a branch of applied mathematics. This volume covers only plane trigonometry, omitting spherical trigonometry.

It deals with angles, circles and triangles, right angles and angle functions, values of functions of acute angles and trigonometric tables, right triangle calculations, functions of any angle, and properties and calculations of oblique triangles. The final chapter deals with relations among the trigonometric functions, such as: the sine and cosine of the sum of two angles, functions of double angles and half angles. Tables of trigonometric functions are given at the end of the book.

The final volume in the series is devoted to the Calculus which has primarily to do with calculations involving rates of change of variable quantities. Here continual use is made of algebra and trigonometry in dealing with equations, angle functions, formulas, etc., so that those subjects must be studied first, although the calculus is no more difficult than the others. This book aims to present the calculus in an informal manner and to illustrate its applications with problems from everyday observation to the physical world and from applied science and engineering.

In the first chapter the fundamental ideas of rates and differentials are explained, then follow chapters on functions and derivatives, differentials of algebraic functions, uses of rates and differentials in solving problems, differentials of trigonometric functions. Velocity, acceleration and their derivatives are given and interpretation of these by means of graphs is explained. Next the solution of maximum and minimum values and problems in this field are given. This is followed by differentials of logarithmic and exponential functions. Finally we come to reversing the process of differentiation, that is, integration, with the various formulas, interpretations by means of graphs and the use of integrals in solving problems. The final chapter contains a very interesting discussion of the natural law of growth and the number "e." This is designed to bring out the mathematical demonstrations of a natural law of growth or decay in nature, such that when not influenced by external or artificial means, the rate of change of any active quantity at any time is proportional to the amount present at that time. This discussion explains why the value of "e" in mathematics comes out 2.718+ and goes into the relations of other logarithms to the base 10 and hyperbolic functions, also a detailed explanation of the value of π.

This series seems to be a very practical self-study treatment of the entire subject. Certainly no engineer can get very far without a knowledge of arithmetic and algebra, at the very least. The more geometry and trigonometry he knows in addition, the better; and even though he never needs to use the methods of the calculus in his daily work, nevertheless a knowledge of its principles brings together all he has learned up to that point and shows him why a great many things are so.

Learning to Weld, published by The Lincoln Electric Co., Cleveland, Ohio, 32 pages, 5½ by 8½ inches, 83 illustrations including photos and drawings, bound in good quality paper cover, price postpaid anywhere in U. S. A. 25c per copy, elsewhere 35c per copy.

Learning to Weld provides a simple basic approach for anyone interested in making a start in arc welding. The booklet's purpose is to teach how to weld and to assist in applying arc welding to the repair of broken parts, the hard surfacing of worn parts and the building of miscellaneous equipment. From the information contained in the booklet, the person interested in arc welding gains clear insight into important aspects of the subject on which he may add further knowledge as he desires.

Subjects treated include the following: protective clothing and equipment; striking the arc; various welding positions; types of welds; fit-up of parts; procedures for various welds including fillets in horizontal, flat, vertical and overhead positions, butt welds, lap welds, corner and edge welds; welding cast iron: hard surfacing.

There are four pages containing 22 illustrations of typical applications of arc welding in repair and construction. Also included are conversion tables on decimal equivalents and thicknesses of metal in both gauge and inches. There is also a glossary of welding terms.

Electronics for Industry, by W. I. Bendz; First Edition; 501 pages; 6 by 8½ inches; cloth; illustrated; published by John Wiley & Sons, Inc.; 440 Fourth Avenue, New York; 1947; price $5.00.

This is a practical non-mathematical work, dealing with the industrial application of electronic control circuits, power rectification and induction, and high-frequency di-electric heating. Written by a Westinghouse Electric Corp. engineer, the book outlines the function of all kinds of electronic tubes and furnishes a workable background of the basic circuits frequently used with industrial devices. It was designed principally for engineers whose training with power equipment has become directed towards electronic apparatus. The book is really the result of the authors instructing several classes designed for practicing engineers already familiar with the fundamentals of electric circuits. It is certain that consulting engineers, plant electrical engineers and electricians will be interested in reading this book.

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